THE UNIVERSITY OF ALBERTA

USE OF TWO SPECIES OF RODENTS IN THE CLASSROOM

by

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled "Use of Two Species of Rodents in the Classroom," submitted by Jane Dyke, in partial fulfilment of the requirements for the degree of Master of Education.

ABSTRACT

In May, 1969, thirty randomly-selected Grade VIII science teachers in Edmonton were interviewed to determine the extent of use, and attitude toward use, of live feral mammals in the classroom. The results suggested probable relationships between the use of live mammals and the following teacher characteristics: education in biology teaching methods; number of biology courses taken; and experience in teaching science.

Twenty percent of the teachers interviewed kept live mammals, but only seven percent had feral species in the classroom over periods ranging from half a day to eight months. These animals were brought and cared for by students, were housed in commercial or home-made cages, and were fed improvised or commercially-produced diets. They were used to illustrate few concepts, but the teachers felt that the presence of the animals greatly promoted student interest and presented very few, if any, problems. The teachers suggested that feral mammals are not used extensively in classrooms because they require extra teacher involvement, added facilities in the classroom and a greater knowledge of biology on the part of the teacher. Mice, gophers and rabbits were thought by many

teachers to be of potential use to illustrate concepts in ecology and anatomy. Seven recommended their use for motivational purposes, four for teaching animal care, and three thought that they could be used to teach species recognition. These results suggest that live feral mammal species are not extensively used in junior high school classrooms in Edmonton, and that teachers need to be made aware of the pedagogical potential of these animals, as well as given information on their collection, care and use.

Procedures for collecting, maintaining and using the red-backed vole (*Clethrionomys gapperi athabascae*) and the deermouse (*Peromyscus maniculatus borealis*) in the junior high school classroom were investigated from 1964-1969 in the field, laboratory and classroom, supplemented by a review of the literature. It was found that these animals could be maintained easily and inexpensively in the classroom and that a wide variety of simple and inexpensive experiments could be carried out by junior high school students to illustrate basic concepts of biology. The effect of their use on learning was not determined, but it is the opinion of the writer that the use of such live species in the classroom has genuine potential in the teaching and learning of many concepts in biology and might well lead to a greater awareness of living forms and their interrelationships with factors of the environment.

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TABLE OF CONTENTS

CHAPTER PAGE

CHAPTER PAGE

CHAPTER PAGE

LIST OF TABLES

TABLE		PAGE

LIST OF FIGURES

FIGURE PAGE

CHAPTER I

INTRODUCTION

I. THE BACKGROUND OF THE STUDY

Need for Curriculum Change in Science Education

Science consists of a body of organized knowledge and a manner of investigating phenomena (MacArthur and Connell, 1966). Strategies of learning are thus related to conditions that will lead to an understanding of the conceptual structures of science and modes of scientific inquiry. Over the years, varying emphasis has been placed on the fulfillment of these two basic goals of science education, particularly in practice. In the currently used Alberta program of studies for Grade VII and VIII science (Government of the Province of Alberta, 1962), these two aspects are given equal emphasis as far as the written objectives are concerned, but an analysis of the actual program indicates that the acquisition of content is the foremost aim, and scientific method is used primarily to confirm known conclusions.

Three factors have led to a recent re-evaluation of the aims and practices of science education. The first, which was probably the most effective, was the result of international competition in the post-Sputnik era, which

provided the catalyst for change in the United States, and consequently, in Canada. Secondly, increased understanding of the learning process, as illustrated by Piaget and the Geneva School of Psychologists gave science educators a further impetus to revise content and teaching procedures. Thirdly, the body of scientific knowledge is growing at an exponential rate, and it is not possible for any person to assimilate and retain all knowledge, accumulated to date, even in one narrowly prescribed area. It would appear necessary either to select from the overwhelming volume available or to generalize.

Curriculum Change in the Alberta Junior High School Life Sciences

The Alberta Junior High School science curriculum is presently in the throes of revision in the light of preceding events. Although the new program will not be adopted until September 1970, the general aims and conceptual schemes of the program have been formulated. Briefly, the primary objective of this program is the development of an inquiring mind and scientific attitudes by means of student investigation (Powley, personal communication). This approach to science education is not new. Dewey (in Hurd, 1961) advocated its use in his definition of science:

> . . . science is primarily the method of intelligence at work in observation, in inquiry and experimental testing; that, fundamentally, what science means and stands for is simply the best ways yet found out by which human intelligence can do the work it should do, ways that are continually improved by the very process of use.

Briefly, inquiry involves active research by the student, wherein the student takes the role of the scientist in the solution of a relevant problem organized by, or in conjunction with, the teacher (Sund and Trowbridge, 1967). With the inquiry method, it is not uncommon for the majority of the students' time to be involved in laboratory work with some time being spent in group discussion (Sund and Trowbridge, 1967).

In conjunction with this revised approach, the content of the science program in this province has also been reorganized to meet the demands of the new philosophy. Life sciences, once artifically divided into the study of plants and animals in grades VII and VIII respectively, will now be combined and taught at the grade VII level only.

The life science program is intended to be flexible, with three texts authorized for use in the classroom with the understanding that other relevant materials will also be used. The designers envisage the future development of intra-school life science programs based on the needs, interests, and available materials in a particular school, within a framework of common

objectives (Melnychuk, personal communication).

One of the authorized references for the new program is Nuffield's Biology: Text I (1967) and II (1966) which are part of a program developed by a team of scientists and educators in Great Britain. The writer is presently involved in a pilot project (1968-69) which is attempting to evaluate this program. One of the questions being asked is the applicability of this course to the Alberta situation in terms of the types of organisms suggested for study.

The results of the pilot evaluation of this course and others such as Life: Its Forms and Changes (Brandwein, Burnett and Stollberg, 1968) and Exploring Life Science (Thurber and Kilburn, 1967) are not yet complete. In the writer's experience with the Nuffield program certain limitations have become evident. Naturally, local Alberta organisms are not dealt with. As a matter of fact, many of the organisms used in the text to exemplify life processes are not found in Alberta at all. Although the early stages of student investigations tend to be more textbook-inspired, as the students later become more skilled in inquiry they are encouraged to initiate independent study. Their activities range beyond the scope of the textbook, and here local resources can play an increasingly important part as subjects of investigation. This seems logical since students tend

to begin to wonder about the organisms that they see about them.

To help rectify the limitations expressed above, Melnychuk, Jacknicke and Visscher (1970) produced a Canadian (Alberta) version of the Nuffield program for the junior high school level. Nonetheless, gaps in information on local resources will remain, and this has encouraged the writer to pursue the present study.

II. PURPOSE OF THE STUDY

The three purposes of this study are discussed independently below.

Present Use of Small Live Mammals in the Classroom

First, the study attempted to determine, through personal interview, what use is presently being made of small live mammals, especially feral species, by a randomly selected sample of grade VIII science teachers in the Edmonton Public School system.

The problems to be considered were:

1. The proportion of the teachers interviewed which used live small mammals, both feral and domestic, in their teaching between September 1 and December 31, 1968.
2. The relationship between the use of small live mammals in the classroom and:

a) sex of the teacher.

b) whether or not the teacher had studied biology teaching methods at the university level.

c) the number of courses in biology and related areas taken by the teacher at the university level.

d) years of experience in teaching grade VIII science.

3. In those classrooms where small live mammals were used, what were:

   a) the activities they were involved in, and over what period of time?

   b) the techniques used in collecting, breeding and maintaining these animals?

   c) the problems encountered?

4. The reasons given by teachers as to why small wild mammals may not be used extensively in the classroom.

5. Native feral mammal species which teachers feel are readily available in the Edmonton area and the potential learning experiences in which these may be used.

Definition of Control Variables

1. Sex of the teacher.

2. Whether or not a teacher studied curriculum and instruction in the teaching of biology. These were not limited as to date or place taken.
3. Number of university courses in biology or related areas taken by the teacher.
4. Years of experience teaching grade VIII science. The number of years was not limited to consecutive years, but was limited to the present program which was introduced twelve years ago.

Hypotheses

The major null hypotheses tested were:

H_1: There is no relationship between the use of small live mammals in the classroom and the sex of the teacher.

H_2: There is no relationship between the use of small live mammals in the classroom and whether or not the teacher took a course in curriculum and instruction in biological sciences education.

H_3: There is no relationship between the use of live small mammals in the classroom and the number of university courses in biology and related areas taken by the teacher.

H_4: There is no relationship between the use of small live mammals in the classroom and the number of years of teaching experience in grade VIII science.

If the null hypotheses were rejected at the five percent level of confidence, this was attributed to random sampling.

Limitations

1. The population, that of grade VIII science teachers with the Edmonton Public School Board during the year 1968-69, although perhaps representative of a large urban teacher population, may not be representative of the majority of Alberta grade VIII science teachers.
2. The sample of 30, selected randomly, represented approximately one-half of the grade VIII teachers of science in the public school system in 1968 who were following the program of studies as authorized in 1962. Teachers of pilot projects at this level were not included in the study, as this was felt to introduce many new variables which were beyond the scope of this study.
3. This study was limited to the consideration

of only the grade VIII science course although others, at the secondary level, involve the study of animals as well.

4. Information from only one part of the interview, that concerning the use of mammals in relation to teacher characteristics, was amenable to statistical analysis.
5. Responses of the interviewed teachers dealing with the use of mammals in the classroom referred to a period extending from September 1 to December 31, 1968.

Trapping and Maintenance Techniques

The second purpose of this study was to determine efficient methods of snap- and live-trapping the red-backed vole (*Clethrionomys gapperi athabascae*) and the deermouse (*Peromyscus maniculatus borealis*). In addition, methods of successfully maintaining these two species in the classroom were considered.

The questions to be answered were:

1. Where are these two animals found, in terms of distribution, in the province and what are their preferred habitats?
2. With what equipment and under what conditions might collection of these animals be carried out successfully?

3. How can these animals be successfully transferred from the field to the classroom?
4. How can these two rodent species be maintained in the classroom?

Limitations

1. The two small rodent species studied are not found throughout the entire province of Alberta.
2. The red-backed vole, and possibly the deermouse, undergo population fluctuations, and are not as readily available some years as in others.

Utilization of the Red-backed Vole and the Deermouse in the Classroom

The investigation of possible uses of the red-backed vole and deermouse in the grade VIII science classroom, with a view to facilitating instruction in the future grade VII course, formed the third part of the study.

The problems to be considered were:

1. What biological concepts might be illustrated by the use of these two species in classroom activities?
2. What are the equipment requirements for the above activities?

Limitations

1. The activities suggested do not refer to the content of any particular program.
2. The activities were limited to those that require unsophisticated equipment.
3. No attempt at evaluation of the effectiveness or appropriateness of the activities in terms of learning behavior were made.

III. SIGNIFICANCE OF THE STUDY

Theoretically, most educationists and scientists feel that the study of living organisms has a place in life science programs. Before the effect of these activities on learning can be determined, however, it is necessary to do preliminary work on the subject to determine the present utilization of living specimens in the classroom, and the opinion of teachers on their use. Jacknicke (1968) did a study to determine the extent of utilization of living organisms in a rural Alberta school system, in addition to a survey of freshwater organisms available in the province. He found that the teachers interviewed made little use of local organisms in their classes. While many reasons were given by the teachers for not using live specimens, the majority of them can be roughly categorized as lack of classroom facilities and lack of teacher knowledge of local fauna. Jacknicke

attempted to outline simple techniques for collecting and culturing common freshwater invertebrates and also gave some suggestions regarding the use of these organisms in the classroom.

In the first place, this study should provide background information on two small native rodents which may be useful to teachers of life science in the province. Secondly, by determining the present utilization of small live animals in city classrooms together with the reasons which a sample of teachers give for using, or not using them, this research may give some insight into the problems to be faced in the initiation of an experiment-oriented life science program at the junior high school level.

IV. DEFINITIONS

Although most of the terms encountered are explained when first used, it was felt that a reference list might be helpful to the reader.

<u>Biology Methods Course</u> refers to a university course in curriculum and instruction in the biological sciences.

<u>Collection</u> refers to the capture of animals, dead or alive.

<u>Deermouse</u> is used as the common name for <u>Peromyscus maniculatus borealis</u>.

Ditch is used to mean any depression lying parallel to a road.

Domestic refers to animals available from pet stores and other retail outlets.

_E. P. S. B._ is used as an abbreviation for the Edmonton Public School Board.

Elevator refers to any commercial grain-storage building.

Farmstead refers to the area encompassing farm buildings.

Feral refers to native or introduced animals found living in a wild state and not generally for sale at retail outlets.

Grade VIII Science Teacher refers to a teacher of at least one class of grade VIII science using _Science Activities II_ as a text or reference. Teaching of one unit of life science also qualified the teacher as a member of this category.

Granary refers to a privately owned grain-storage building.

Jackpine-juniper refers to an area covered primarily with an overstory of jackpine trees (_Pinus banksiana_) and an understory of juniper (_Juniperus communis_ and _J. horizontalis_).

Lab Chow consists of commercially produced food pellets.

Maintenance is used to mean the act of housing and feeding live animals.

Muskeg is used to refer to a sphagnum bog with a sparse covering of black spruce trees (*Picea mariana*).

Poplar stand refers to an area covered primarily by an overstory of poplar trees (*Populus tremuloides*).

Pasture refers to cultivated grass land used for livestock.

Railroad Right-of-way refers to Crown land running parallel to railroad tracks.

Red-backed Vole refers to *Clethrionomys gapperi athabascae*.

Trap Nights are the total of the products of numbers of nights and number of traps.

Trapping Success is the percentage of traps filled.

White Spruce refers to an area with an overstory of white spruce (*Picea glauca*).

Woodlot refers to any treed area surrounded by open area.

University Biology Course refers to any course dealing with living organisms, whether directly or indirectly, applied or theoretical.

Use of Mammals refers to there being live mammals other than humans in the classroom during the period from September 1 to December 31, 1968.

CHAPTER II

REVIEW OF RELATED LITERATURE

Theoretical Considerations of Live Organism Teaching

Many educators and scientists feel that the study of living organisms is neglected in most life science programs (Vance, 1952; Simons, 1955; Dana, 1956; Trump, 1947; Conklin, 1940; Meyer, 1954; McConnell, 1953; Mallinson, 1955; Larson, 1955; Smith, 1951; Stork, 1951; Parker, 1948; and Novak, 1942). Cole (1954), for example, feels that it is a sad commentary on teaching procedures that life science is devoted to the study of dead organisms.

Living organisms, besides exhibiting the characteristics of life, can be used in the classroom for the following purposes:

1. To create student interest (McEwan, 1950).
2. To act as subjects for scientific investigation (Miller, 1951).
3. To expose potential biologists to a wide variety of organisms before they begin to specialize (Netting, 1948).

In practice, however, the use of live organisms has not been fully exploited. Even Louis Agassiz, who

strongly advocated that one "study nature--not books" (Weaver, 1947), based many of his students' activities around nature that had been preserved in formalin. In all the literature reviewed, the impression was given, either implicitly or explicitly, that although living organisms should be used in life science classes they, in fact, are not.

Experimental Evidence Concerning Live Organism Teaching

To the writer's knowledge, no experimental studies have been done in North America to determine the effect of using living organisms in the laboratory or classroom on learning. Two types of studies exist, however, which might be relevant to this subject. One type compares laboratory and/or lecture and/or discussion as teaching techniques. The other type compares the use of field trips with within-classroom teaching.

In the first half of the century, educational researchers were primarily concerned with comparing the merits of lecture-demonstration with those of the individual laboratory method. Studies of this kind, by Anibal (1926), Atkins (1936), Barnard, (1942), Cunningham (1924), Downing (1925), Isenberger (1925), and Lantz (1939), however, showed no significant differences between the two methods of instruction.

Anderson, Montgomery, and Ridgeway (1951), in

attempting to discover the relative value of various multi-sensory methods in the teaching of high school biology, discovered that students in the film-with-laboratory group achieved significantly better than students of the control (textbook method group) and better than the film group and the laboratory group. Differences in mean achievement of the last three groups were not significant.

Oliver (1961) compared the relative effectiveness of lecture, discussion, and laboratory work in high school biology, and found no significant differences.

The latest trend in investigation, represented by Coulter's study (1966), compared the effectiveness of inductive laboratory, inductive demonstration, and deductive laboratory in biology, using ninth grade students. He found the deductive and inductive methods to be equally effective in terms of learning factual information, application of principles, and critical thinking.

In all of the above studies, no mention is made of the specific laboratory or demonstration activities in which the students were involved. It might be that few, if any, living organisms were involved in the studies which, therefore, would not be particularly relevant to the present investigation.

The writer has found only one experimental study which involved the study of living things. Bennett's

(1965) thesis endeavored to compare the effectiveness of two instructional methods, the experimental-field method and the traditional classroom method, involving science content in ecology for the seventh grade in Florida. No significant differences were discerned.

The difficulty faced by all the experimenters cited is primarily that of developing a technique of evaluation that is directly pertinent to the objectives. Cunningham (1946), in analyzing 37 comparative studies, found that neither method was favored in all of these, and that the desirability of one method over the others was determined by the objectives sought and the conditions under which the course was taught. This theory is supported by Mager (1962) although his thesis does not specifically refer to research.

Thus, to date, no substantiated evidence seems to exist as to the usefulness or effectiveness of live organisms in the teaching of biology.

Extent of Live Organism Teaching at Present

Very little information has been collected indicating the uses to which live organisms are put in the classroom. This is particularly true with respect to local organisms. A study by Cyril Abbott (1954) which involved a self-stamped postcard sent to biology teachers in fifty large high schools in ten states of the U.S.A.

revealed that only eight percent of the schools used living specimens in their classes. It might be added that response to the questionnaire was very poor, and that no information was obtained as to the actual use of the organisms. Taylor (1965) made an unsubstantiated statement that 80 to 85 percent of all teachers are unfamiliar with the use of plants in the classroom.

The only study that has been done in any depth to find out the extent to which living organisms are used in the teaching of biology was completed by Jacknicke (1968) at the University of Alberta. His chief concern was the use of local freshwater invertebrates in the schools in the County of Lacombe at the eighth and eleventh grade levels.

Of the eleven teachers interviewed, seven used local organisms in the classroom with only two of these teachers being actively involved in their collection. In the other cases, students brought the organisms to the classroom. Of the various animal phyla, arthropods and protozoans were the most frequently utilized. Of particular interest to the writer is that the native small mammals were poorly represented in the classroom. Rodents were the only mammals used with two teachers using field mice and one also having gophers. Only one teacher cultured vertebrates and these were frogs and salamanders.

The other question which Jacknicke's study attempted to answer was what biological concepts were illustrated by the use of local organisms. Only one concept was common to five of the seven teachers using local organisms, that being classification. The other uses could be called illustrations of science processes such as introducing the microscope and manipulation of materials. Other uses varied greatly, and included illustration of insect life cycles, introduction to cells, awareness of local environment, teaching of observation skills, illustration of animal movement, anatomy, and motivation of students. Unfortunately, it was beyond the scope of Jacknicke's study to determine in detail the activities carried out and the amount of time spent on them. It was Jacknicke's opinion, however, that the organisms were not studied either extensively or intensively.

In contrast to the actual use of the organisms, the teachers often expressed values of using laboratory animals which they did not attempt to realize themselves. Of the total number of teachers interviewed, seven felt that local resources would motivate and stimulate students, although only one teacher actually used organisms for that purpose. The second and third most frequently given reasons for use of local resources were: to develop an appreciation of the local environment (four teachers) whereas only one teacher used organisms for

this purpose; and to have more "meaningful" teaching (three teachers), although none did so. The other seven reasons, each given by one teacher, were as follows: to illustrate taxonomy, to stimulate student involvement, to observe the organisms first hand, for economy, to build a permanent collection, to illustrate agricultural controls, to have "better teaching" by means of a laboratory approach.

The reasons given by the teachers for not using local resources can be roughly grouped into three categories: inconvenience, lack of teacher knowledge, and lack of student interest (Table I). It is difficult to determine accurately the most significant category of responses because the teachers did not rank them. It would appear, however, that lack of functional biological knowledge was an important factor contributing to the limited use of local resources.

This conclusion may be partially substantiated by an extensive survey of American Biology teachers in 1940 (Riddle, 1941), in which many teachers volunteered the information that there was a need for more functional biology courses at the university and college level for teachers-in-training. This study, while not recent, may be applicable to the Alberta situation. By "functional" is meant that the teachers become involved in activities which can also be carried out by the students in the

TABLE I

REASONS GIVEN FOR NOT USING LOCAL RESOURCES
(modified after Jacknicke, 1968)

REASON GIVEN	NUMBER OF TEACHERS GIVING REASONS
Inconvenient:	
Too time consuming	7
Organisms not present year-round	2
Organisms not present in some localities	1
Inconvenient	1
Difficult to culture	1
Inadequate physical facilities	5
TOTAL	17
Lack of Teacher Knowledge:	
Inadequate knowledge of what organisms exist locally	7
Inadequate knowledge of where organisms are found	7
Inadequate knowledge of culturing techniques	7
Inadequate knowledge of how to obtain specimens	6
Inadequate teacher background and training	3
TOTAL	23
Lack of Student Interest	1

classroom. More recently, McEwan (1950), Hadsall (1952), and Domm and Blaydes (1949), all commented on the inadequate exposure of teachers to functional courses in biology. This also reflects on college and university courses wherein local resources are not used to a great extent.

To conclude, the writer feels that three pertinent points arise from the previous discussion. Firstly, if Lacombe biology teachers can be considered representative, local resources are not extensively used in Alberta schools in the teaching of biology. This may possibly be the result of ignorance or lack of awareness of local flora and fauna and their possible uses. Secondly, the uses of live organisms for teaching purposes had been determined for a very small population of teachers in one rural area only. Thirdly, a review of the pedagogical literature reveals that while there are many suggestions for the use of living organisms in the classroom, and a fairly extensive study of the possibilities of using Alberta freshwater organisms (Jacknicke, 1968), there is a dearth of information available to teachers regarding the use of native small mammals.

CHAPTER III

THE ANIMALS

Two types of small mammals could be used in the classroom: domestic and feral. The domestic species can be obtained from pet stores and biological supply houses and other retail outlets. Examples of domestic small mammals are albino mice and rats, guinea pigs, hamsters, gerbils, and rabbits. Native mammals in the province of Alberta include a wide variety of terrestrial rodents such as voles, mice, gophers, chipmunks, and ground, tree and flying squirrels. These native species may often be obtained from the local environment. Some require a permit.

The fact that only two teachers in Lacombe County had field mice in the classroom (Jacknicke, 1968), and that these were not referred to by their specific name, appears to indicate that there exists a large untapped local resource for classroom studies in the small feral rodent species of the province.

I. REASONS FOR THE CHOICE OF ANIMALS IN THIS STUDY

Since it is beyond the scope of this work to entertain possible uses for all native mammal species in

the province, or for that matter, all the rodents, the writer decided to limit the study to two Cricetids commonly found throughout Alberta--the red-backed vole (*Clethrionomys gapperi athabascae*) and the deermouse (*Peromyscus maniculatus borealis*).

These two species were selected for several reasons:

1. They are good subjects for comparative studies because:
    a. they have very similar surface area to volume ratios, making adjustments unnecessary in experiments where this is important.
    b. they exhibit different activity rhythms.
    c. they demonstrate different food habits and thus they also have different internal morphology (e.g. teeth, intestines).
    d. they can often be found in the same habitat.
    e. they have different body forms, which also reflect behavioral differences (e.g. locomotion).
2. They are small animals and thus:
    a. require a small living space.
    b. require small, and consequently, inexpensive and simple equipment for their

collection and maintenance.

c. require little care in terms of feeding and cleaning.

d. many individuals can be used in experiments to obtain meaningful information.

3. They are easily obtained because of their numbers and almost ubiquitous distribution.

4. They are considered to be vermin and thus they may be collected and held in captivity with impunity.

5. They can be returned to their native habitat easily once they are no longer required.

6. Based on personal experience, they can be considered manageable in that:

   a. they do not commonly carry diseases communicable to man.

   b. they cannot inflict serious wounds when handled.

   c. they tend to become fairly tame in captivity.

   d. they survive well in captivity, even with constant handling.

7. They are attractive to children.

8. Their reproductive capacity is conducive to experiments in that:

   a. they mature quickly, requiring only about

one month.

b. they have many young, with litter sizes numbering from six to eight.

c. there is a rapid turn-over in the population which makes possible studies of genetic variability.

9. They require small amounts of inexpensive and easily obtainable food.

II. NATURAL HISTORY

Family Cricetidae

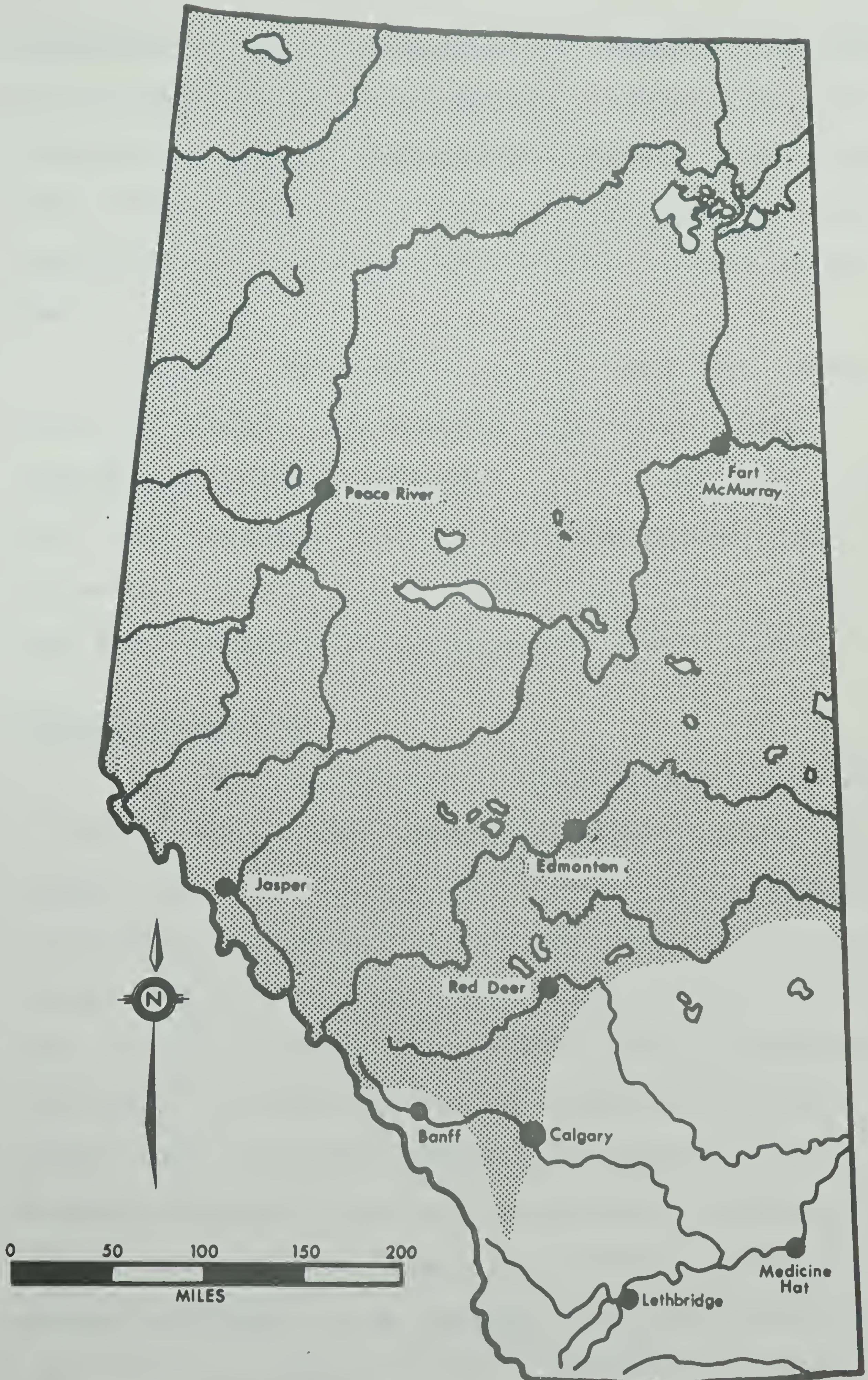
The red-backed vole and the deermouse are representative of two sub-families of the Family Cricetidae, the Microtinae and Cricetinae, respectively. The Family Cricetidae includes small to medium-sized rodents such as the voles, lemmings, mice, and rats. Since natural history and physical features of this group are widely diversified, it is difficult to describe the group. Most of them have four toes on the front foot (some, five) and all have five toes on the hind foot. Their tails are rarely bushy, but have a short hair covering. Mice and rats have large ears and eyes together with long tails; lemmings and voles have short tails, small ears and eyes, and usually, long fur on the body. All have gnawing teeth and six cheek teeth in the upper and lower jaws (Burt and Grossenheider, 1964).

The Deermouse

The deermouse belongs to the sub-family Cricetinae, a widely distributed group of mice, and the Tribe Hesperomyini, which is restricted to the New World, from Alaska to Patagonia (Cockrum, 1962). These mice are all characterized by their white feet, white bellies and tail underparts, with some shade of brown on the upper parts. The tail is relatively long in many of the species, as exemplified by the deermouse, where the tail is as long as the rest of the body. They are nocturnal, thus they have large protruding eyes.

Peromyscus maniculatus borealis is found almost throughout the province of Alberta, excepting the mixed-grass prairie region in the southeast and the southern portion of the Rocky Mountain zone (Figure 1). Another subspecies also found in Alberta is the sagebrush deer-mouse (*P. m. artemisiae*). It is found in the extreme southwestern area up into the Rocky Mountain zone, where it intergrades with *P. m. borealis*. This subspecies also intergrades with the osgood white-footed mouse (*P. m. osgoodi*). The latter is found in the dry, southern plains of the province, ranging in typical form on the third prairie steppe from near the foothills, to the eastern boundary, to the southern fringes of the aspen poplar forest. Around the perimeter of its range it intergrades gradually with both *P. m. borealis* and *P. m.*

Figure 1. Map showing distribution of the deermouse (*Peromyscus maniculatus borealis*) in the province of Alberta (Soper, 1964).


Peace River
Fort McMurray
Jasper
Edmonton
Red Deer
Banff
Calgary
Lethbridge
Medicine Hat
N
0
50
100
150
200
MILES

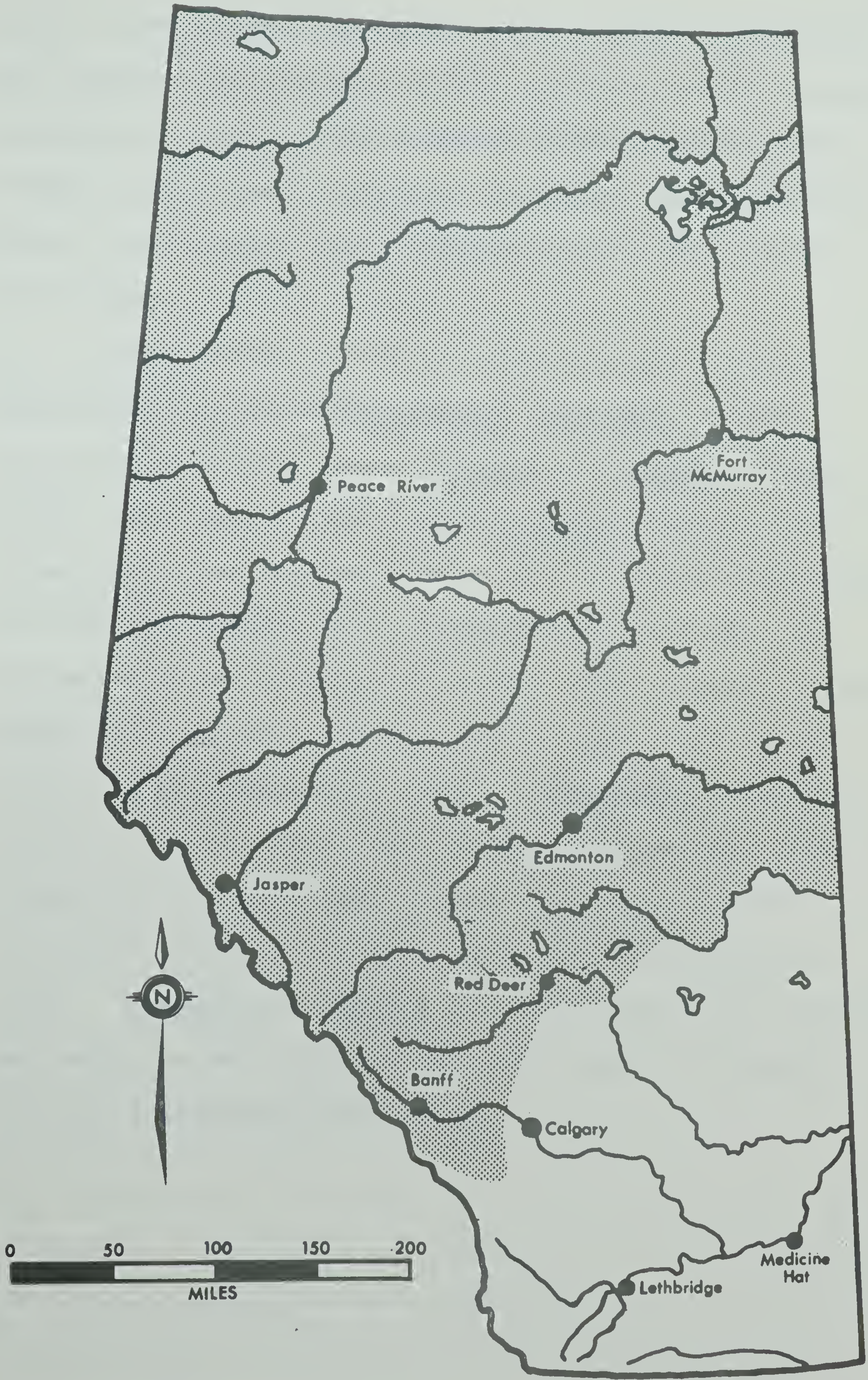
artemisiae. Both the artemisiae and osgoodi subspecies are distinguishable from borealis by being lighter in coloration. However, distinctions between subspecies are very difficult where the ranges overlap, and thus even competent authorities are often unable to distinguish them.

Only one other species of the Tribe Hesperomyini exists in Alberta, the badlands white-footed mouse (Peromyscus leucopus aridulus). It is restricted to the Milk River drainage south of the Oldman River, north on the eastern side to about the Red Deer River. It is very rare and infrequently captured (Soper, 1964).

The Red-backed Vole

The red-backed vole is a typical representative of the Sub-family Microtinae. This group consists of animals that are thick-set with bluntly rounded muzzles. The greater part of each leg is set close to the body, giving them a short-legged appearance. The tail is short, never as long as the head and body. The Tribe Microtini, to which the vole belongs, is found in Europe, Asia and North America. The red-backed vole is abundant throughout most of the province, excepting the extreme southern area (Figure 2). There two other subspecies are found, C. g. loringi, the plains red-backed vole, and C. g. galei, the gale red-backed vole (Soper

Figure 2. Map showing distribution of the red-backed vole (*Clethrionomys gapperi athabascae*) in the province of Alberta (Soper, 1964).


Peace River
Fort McMurray
Edmonton
Jasper
Red Deer
Banff
Calgary
Lethbridge
Medicine Hat
N
0 50 100 150 200
MILES

1964). The plains red-backed vole is found largely in the Cypress Hills region of the province, while the gale redback is found in the southern Rocky Mountain zone. Slight variations in physical features, mainly in the skull, distinguish these subspecies from the vole of this study.

Other voles in the province include various species of the genus Phenacomys, Microtus, and one species each of the genus Pedomys and Lagurus (Soper, 1964). The meadow vole (genus Microtus) may be distinguished from the red-backed vole by color differences, in that the redback has a reddish back with gray or yellowish sides whereas the meadow vole is gray, faintly washed with brown, with silvery to light buffy sides (Burt and Grossenheider, 1964). Phenacomys voles are found in the mountains and can be distinguished from the redback by its gray body washed with brown and the yellowish tinge on its face (Burt and Grossenheider, 1964). Pedomys and Lagurus are both true prairie species, and both are much lighter in color than the redback (Burt and Grossenheider, 1964).

CHAPTER IV

METHODS

PRESENT USE OF LIVE MAMMALS

The Interview

The first part of the study concerning present utilization of live small mammals by a sample of Edmonton teachers of grade VIII science was investigated by use of a personal interview.

The interview was selected as the instrument for obtaining data for several reasons. In addition to providing an access to objective data concerning teacher characteristics, the procedure gave the opportunity of obtaining the opinions of the teachers without the restrictions characteristic of a questionnaire. It was felt that the personal contact with the respondents might elicit more candid responses, and also allow for clarification of questions and answers, thus providing more accurate information (Good, 1966). The interview is advantageous in giving the researcher clues, other than verbal ones, as to the true feelings of the respondent. This might be particularly desirable where a teacher feels that his status may be affected by an answer.

A schedule of prepared questions (Appendix I) was used in order to reduce, as much as possible, bias and variability in the interviews, without restricting communication between the interviewer and the respondent.

The interview opened with a brief explanation of the purpose of the study, followed by the assurance that the information obtained would be kept anonymous. The initial questions attempted to obtain general information about the teacher and the number of students taught. This included sex of the teacher, years of teaching experience with grade VIII science, number of biological science methods courses taken and the number of university biology and related courses studied.

Explanation of Interview Questions

1. What live mammals did you use with your science classes from September 1 to December 31, 1968?
   This question was meant to determine what species of mammals, and numbers of each, were used in the classroom during the time suggested by the program of studies for the study of mammals.
2. Where and how did you obtain these animals?
   The purpose of this question was to determine the method of collection, the collector, and the locality of collection. In addition, this information would enable the interviewer to determine who initiated the

collection and/or use of live small mammals--the teacher, the student or both.

3. How did you house these animals? (i.e. What types of cages did you keep these animals in?)

   This question was meant to give the interviewer information as to whether the cages were commercially- or home-made, or whether they were adaptations of equipment meant for other use (e.g. aquaria). Also it seemed desirable to determine whether the school or the students were responsible for the acquisition of the equipment.

4. What did you feed these animals?

   The diet on which the captive animals were maintained was determined in order to add to the writer's information concerning possible food for small mammals.

5. Were you able to breed any of these animals successfully? If so, on how many occasions?

   This question was meant to reveal, in addition to breeding success in captivity of different species of mammals, whether or not the teacher actually did keep the animals for any length of time in the classroom.

6. Did you find that having these animals posed any difficult problems? If so, what was the nature of these problems?

   The purpose of this question was to establish the

disadvantages, if any, of having animals in the classroom.

7. Did you find that there are advantages to having these animals in your classroom? What advantages?

   The teacher could here give his opinion on the value of having live mammals in the classroom.

8. For what specific purposes did you use these animals?

   Here it was hoped to elicit specific information about appropriate classroom activities related to the use of the animals in order to secure ideas as well as to determine one aspect of the extent to which the teacher utilized these animals.

9. How long (weeks) did you maintain these mammals in your classroom?

   The question was meant to obtain one other component of the extent to which live mammals were used in the classroom.

10. For what reasons do you think teachers may not be making more extensive use of small wild mammals in their classrooms?

    In order to determine why a teacher does not utilize feral mammal species, without causing that teacher to become defensive, it was felt necessary to phrase the above question in an impersonal fashion.

11. What small wild mammals found in the Edmonton region are readily obtainable for use in Junior High School

science classes?

12. For what purposes might these wild animals be used in the science classroom?

    It was hoped to obtain teacher's opinions on both the concepts and specific activities for which he felt native mammals could be used. This question might also disclose the extent of the teacher's knowledge about such activities.

Pilot Study

On April 13, 1969, letters of intent (Appendix II) were sent to the five teachers selected for the pilot study. These Junior High School science teachers with the E. P. S. B. were interviewed during the period from April 13 to April 17, 1969. The sample consisted of teachers who were known to use live mammals in the classroom extensively and those who did not use any at all. Two of them were teaching grade VIII science and the other three were involved in pilot studies on life science at the grade VII level. The reason for this selection was to avoid reducing the total population from which the sample for the actual study would be taken.

The pilot study was conducted in order to evaluate the twelve questions in the interview schedule. As a result, the wording of one question was slightly

altered, but no major changes were made. It was felt that the schedule of questions would probably elicit the information desired.

Method of Conducting the Interview

Examination of a list of grade VIII science teachers obtained from the Edmonton Public School Board revealed that of the total of 107, 74 were teaching the authorized version with Science Activities II as the text. The population was reduced to 71 when the two teachers used in the pilot study were eliminated, together with the writer. Of these, 40 teachers were selected for interview by use of a table of random numbers. Later consultation with the schools revealed that two of these teachers were no longer with the school board, seven others had unofficially adopted an earth science program, and one teacher refused to be interviewed. Thus the sample was reduced to 30 and the population to 61. The other teachers in the population were later contacted to determine if any others had unofficially undertaken a new program. Only five had done so, reducing the population to 55 who taught a total of 1,780 grade VIII science students in 31 schools.

In January, 1969, permission was obtained from the E. P. S. B. to interview teachers outside of school time. Letters of intent (Appendix III) were mailed to

the potential interviewees on April 15, 1969. Later, telephone calls were made to each teacher to determine if he were willing to be interviewed, and if so, a convenient time and place was arranged. The interviews took place during the period from April 19 to May 16, 1969. In most cases the interviews occurred in the school of the teacher, but in one instance, the interview took place in the writer's school, and one in the home of the respondent.

The writer recorded responses during the course of the interview on a coded, dated, interview schedule (Appendix I). This was felt to be preferable to a taped interview in that the teacher response might be restrained in such a situation. The responses were recorded immediately to reduce, as much as possible, errors of ommission and commission.

Population Variables Used in the Study

In order to determine whether or not there were significant differences in teacher use, opinion of and knowledge of the use of live mammals in the classroom, the respondents were categorized according to six population variables. The categories, numbers and percentages of respondents within each category are shown in Table II.

Method of Analysis of Interview Data

Because a random sample was selected for the purpose of the interview, it was necessary to use sampling

TABLE II

NUMBERS AND PERCENTAGES OF RESPONDENTS WITHIN THE CATEGORIES OF THE CONTROL VARIABLES

Sex of the Teacher		
	Number	Percentage of Sample
Male	27	90
Female	3	10
Totals	30	100

Whether or not Biology Methods Courses Had Been Taken		
Were taken	7	23
Were not taken	23	77
Totals	30	100

TABLE II (continued)

Number of University Biology and Related Courses	Number	Percentage of Sample
0	12	40
1	4	13
2	3	10
3	3	10
4	2	7
6	2	7
7	2	7
9	1	3
12	1	3
Totals	30	100

Years of Experience with Science VIII

1	9	30
2	7	23
3	4	13
4	2	7
6	2	7
7	2	7
9	1	3
10	1	3
12	2	7
Totals	30	100

TABLE II (continued)

Use of Live Mammals in the Classroom		
	Number	Percentage of Sample
Did use live mammals	6	20
Did not use live mammals	24	80
Totals	30	100

Use of Feral Live Mammals in the Classroom		
Did use feral live mammals	2	7
Did not use feral live mammals	28	93
Totals	30	100

statistics. It is assumed that the estimates from the sample population represent population parameters.

Data which were felt to be not directly related to the variables under study were tabulated and reported in this form. Nominal data, which involved the categorization of data into equivalent groups, was treated by use of chi-square. Point biserial correlation was used to provide a measure of relationship between a continuous and a dichotomous variable.

In the case of determining the existence of significant differences in the use of live mammals in the classroom and variables of teacher sex, and whether or not a biology methods course had been taken, the data were appropriately cast into 2 x 2 tables incorporating Yate's correction for continuity.

Point biserial correlation was used to determine the relationship between the number of university biology and related courses studied, and the use of live mammals in the classroom, as well as between the number of years of experience teaching grade VIII science and the use of live mammals in the classroom. The continuous variables were the number of university courses in biology and the number of years experience teaching grade VIII science. The dichotomous variable was whether or not live mammals were used in the classroom.

II. TECHNIQUES FOR COLLECTION AND MAINTENANCE

Area of Investigation

The greater part of the field and laboratory investigation concerning this problem took place from May, 1966 until August, 1967 in the Great Slave Lake region of the Northwest Territories. Here the writer assisted her husband in his field research, involving the ecology of the deermouse and the red-backed vole and also carried out her own investigations in the field and laboratory. From September, 1968 to September, 1969, field and laboratory investigations were carried out in the Edmonton area.

Description of Habitats

The date, location, and a brief description of each trapping location is given in Table XIV. The areas trapped represent many of the vegetative zones found in the province of Alberta. It is assumed that those vegetative areas trapped in the N. W. T. would provide useful information applicable to similar ones in this province. Trapping in Alberta was done primarily in the immediate vicinity of Edmonton, within twenty miles of the city limits.

To determine trapping success, trapping locations with similar habitats were grouped together (Table XV) into categories described below. For descriptive

purposes, characteristic plants of the habitat were defined as those occurring in the majority of the locations, and were listed in order of decreasing abundance within the habitats. Overstory indicates the trees of the area while understory refers to the shrubs and tall herbs. Ground cover vegetation is listed and the amount of cover afforded the mouse or vole is described according to the method of Whitaker (1966) as follows:

> . . . very poor when there was no vegetation and as poor when there was little or very thin vegetation; in either situation a mouse would have difficulty moving around without being seen from above. Cover was recorded as fair when the ground was incompletely covered by vegetation or when the vegetation was not too dense; a mouse could find hiding places but would not be able to move about freely without being seen from above. In good cover, the ground was covered by dense vegetation; a mouse would not be visible from above.

Moisture conditions of the habitats were categorized as dry, moist or wet.

Parklike Jackpine. The jackpine was the only species making up the overstory in this habitat. The understory was scant being primarily composed of rose (*Rosa woodsii*) and buffalo berry (*Shepherdia canadensis*). Characteristic ground vegetation included reindeer moss (*Cladonia spp.*), feather moss (*Hylocomium splendens*), bearberry (*Arctostaphylos uva-ursi*), bog cranberry (*Vaccinium vitis-idaea*), and twin flower (*Linnaea borealis*). Ground cover was poor and the soil was very dry.

Jackpine-Juniper. This area also had an overstory of jackpine, but the understory was significantly denser than that of the above. Juniper (*Juniperus communis* and *J. horizontalis*) was common as were buffalo berry, shrubby cinquefoil (*Potentilla fruticosa*), and rose. Ground cover vegetation consisted of reindeer moss, bearberry, various mosses (including feather mosses), various graminoids, and twin flower. The cover ranged from poor to fair and the soil was very dry.

White Spruce. White spruce trees (*Picea glauca*) made up the overstory while buffalo berry, rose, and low bush cranberry (*Viburnum edule*) comprised the understory. The ground cover vegetation consisted of a great deal of feather moss with smaller amounts of twin flower, bear-berry, bunchberry (*Cornus canadensis*), and some grass. Cover ranged from poor to fair. The soil was generally moist.

Sphagnum Bog. This habitat was "mature" in that there was little standing water. Moisture of the sub-stratum ranged from moist to dry, although generally it was quite spongy. The overstory consisted principally of black spruce trees (*Picea mariana*) with a few bog birch trees (*Betula glandulosa*). Labrador tea (*Ledum groen-landicum*) made up the majority of the understory which ranged in abundance from very thick to non-existent. Bog cranberry, reindeer moss, sphagnum and other mosses,

grasses and *Peltigera* (a lichen) made up the ground vegetation. Cover was variable but generally good.

Poplar. The characteristic tree of this habitat was the poplar or trembling aspen (*Populus tremuloides*). The understory was made up of buffalo berry, rose, low bush cranberry and juniper. Feather mosses, grasses, twin flower, and bearberry were characteristic ground plants. The cover was generally very good, with a few poor areas. The soil was moist.

White Spruce - Poplar. Overstory here consisted of white spruce and poplar in about equal proportions. Red osier dogwood (*Cornus stolonifera*), raspberry (*Rubus striginosus*), common nettle (*Utrica gracilis*), various members of the mint family (Family Labiatae), and arnica (*Arnica sp.*) made up the understory. Ground cover consisted of bunchberry, dwarf raspberry (*Rubus acaulis*), mitrewort (*Mitella nuda*), strawberry (*Fragaria virginiana*), twin flower, various mosses and heavy leaf litter. Cover ranged from poor to fair. Soil conditions varied from dry to moist.

Roadside. There was no overstory or ground cover. Various grasses, rose, buckbrush (*Symphoricarpus occidentalis*), Canada thistle (*Circium arvense*), annual hawksbeard (*Crepis tectorum*), purple asters (*Aster spp.*), yarrow (*Achillea millefolium*) and small numbers of other species made up the understory. The soil was dry and

the cover ranged from poor to good. This habitat category included the trapping sites along the railroad right-of-way and in roadside ditches.

Farmyard. This category was characterized by farming and related activities. It included the following trapping locations: a stubble field with straw bales; the interior and environs of farm buildings such as sheds, barns and granaries; and the immediate vicinity of a country grain elevator. Brome grass was the dominant plant species. In some of the areas, wheat and barley straw was available in addition to scattered seeds of cultivated crops. Cover was generally poor and the soil was dry.

Old Field. This category was defined as a habitat provided by a once cultivated area that was not recently disturbed by cultivation or grazing. This grouping included the old pasture and vacant lot. The dominant species was brome grass. Ground cover was good and the soil was dry.

Trapping Methods and Materials

The equipment for the collection of the animals consisted of 20 to 100 snap-traps (Museum Special) and 30 to 60 live-traps (Longworth and Sherman). A mixture of peanut butter, rolled oats and bacon grease was smeared on the pedal of the trap for bait. In addition,

several pellets of lab chow and some Terylene nesting material were placed in the live-trap. During winter, to partly protect the animal from the cold and reduce loss, an external covering of Terylene, enclosed by clear plastic, was taped to the outside of the trap. Since Longworth traps were felt to be best suited to this procedure, they were used exclusively during the winter.

The traps were carried in "Handi-Pak" cardboard fruit boxes which were found to be advantageous in that they were easily obtainable at no cost, had built in hand-holds, were of sturdy construction, and provided easy accessibility to the traps. A field notebook, pencil, and "sandwich size" brown paper bags (for carrying carcasses) completed the gear.

The traps were set out in the late afternoon or early evening and were collected by nine a.m. the next day. The trapping grids were located within 350 yards of the road. The grid consisted of traps placed in lines ten paces apart. The number of lines was determined by the breadth of the habitat and the number of traps used.

The traps were placed among fallen logs and other debris where available. The location was marked so that it could be easily viewed from a distance. The live-trap locations were marked by a red cloth or plastic

ribbon flag attached to a shrub, tree or other protuberance as near the trap as possible. The flag locating the snap-traps was attached at one end to one of the staples holding the spring of the trap, by a yard-long string. Its purpose was to prevent predators from dragging the trap away.

The winter snows presented a problem. A hole large enough for the trap and the trapper's arms was dug into the snow to the earth's surface where it appeared that a fallen log or other debris was located. The trap was then set under or as close as possible to this material thereby providing protection against drifting and proximity to underground rodent tunnels.

The snap-trapped animal was placed in a paper bag and the location, date and species were recorded on the outside. Live-trapped animals were carried in the traps to the laboratory.

In the laboratory, live animals were transferred to cages after they had been weighed, sexed, measured and marked (if necessary). The dead animals were weighed, measured (total body length, length of tail, length of left hind foot, length of ear from notch to tip) and autopsied. Sex and reproductive condition were noted. In some cases, organs were removed and placed in proper preservatives for later study. (These procedures are discussed in detail in Chapter VI.) Observations were

made on parasites present, pelage condition and evidence of injuries. All observations were recorded in the field notebook, including those made in the field concerning weather conditions, vegetation, cover, moisture of substratum, and other relevant material pertaining to the trapping site.

Analysis of Trapping Results

Trapping success was determined as a percentage of traps filled by each species (Table XV). Mean percentage, along with standard error was calculated for each species according to habitat type (Table XVI). Trapping success for each species in the various habitats was statistically compared using the two-tailed t-test. Comparison of success for the two species within a particular habitat was also made using the same test. A probability level of less than .05 was considered to be significant.

The relative success of the Sherman and Longworth live-traps was compared on one trapping area (that of the white spruce-poplar) in terms of both the percentage success of animals captured and the percentage success of their survival.

Neither the effectiveness of the bait nor the comparative effectiveness of the snap- versus the live-trap was determined. Effect of weather conditions on

trapping success was also ignored in the statistical analysis.

Maintenance Methods and Materials

Conditions for maintenance were not uniform but varied according to the materials available. Basically, three types of cages were used in which one to six animals were housed together.

Some of the animals were kept in home-made, $\frac{1}{4}$ inch wire-mesh cages measuring 18 x 12 x 7 inches. The mesh was stapled to an inner structure of one inch square spruce wood. The door was made of wire mesh, 7 x 6 inches, attached by wire hinges and a wire latch. The floor was wire mesh and wastes were collected on newspaper that was changed daily. Food pellets were placed on the cage floor (soon stored by the animals in the nestbox). A wooden nestbox (8 x 3 x 3 inches), made of $\frac{1}{4}$ inch plywood, had a detachable lid and a circular entrance ($1\frac{1}{2}$ inch in diameter) on the side. Terylene nesting material was provided. This proved superior to cotton wool in that it does not absorb moisture from urine. A clear glass water bottle with a curved aluminum sipper tube was suspended from the outside with tightly coiled springs attached to the wire of the cage.

A home-made cage of dimensions 18 x 11 x 15 inches constructed of a spruce skeleton ($1\frac{1}{2}$ x $1\frac{1}{2}$ inches)

covered by 1/16 inch screening with a removable lid made of the same material. The floor was made of $\frac{1}{4}$ inch plywood. Feeding and watering arrangements were the same as those described above.

The animals were also caged in commercially manufactured cages (11 x 7 x 15 inches) made of clear plastic or opaque polypropylene. They were covered with a wire mesh top designed to hold food and a water bottle. A handful of Terylene was used as nesting material and was placed at one end of the cage away from the sipper tube.

The animals were generally fed a basic diet of mouse pellets or lab chow supplemented with a variety of other foods such as apples, raisins, dried bread, milk, rolled oats, cookies and green grass. Some of the animals were maintained on commercially prepared hamster food. The diet of the animals not on strict food regimens was seemingly limited only by the imagination of the students. As a precaution, cabbage was withheld as it is not recommended for other rodents by pet store leaflets.

Small cardboard boxes, the inner cardboard rolls from toilet tissue or a small can were placed in the cage to give the animals environmental heterogeneity and a place to hide.

Litter was used in the plastic cages. It consisted of a variety of materials: wood shavings, newspaper,

paper towelling, toilet paper, or hay, depending on the material available.

The newspaper under the wire mesh cages was replaced and the wooden-floored cages were swept out daily. The litter in the plastic cages was changed twice weekly, usually on Monday and Friday.

The animals were fed daily, except on weekends when they were fed double rations. Wilted food was removed and water bottles were emptied and refilled with fresh water daily, except on weekends. The cages, bottles and sipper tubes were washed weekly in detergent and bleach.

No attempt was made to compare methods of maintenance and care of the animals in captivity.

III. POSSIBLE USES OF TWO RODENT SPECIES IN THE CLASSROOM

Information for this section was gathered both in the laboratory (May, 1966 to July, 1969) and in the classroom during the course of two school terms (1967-68, 1968-69) and involved approximately 60 grade VIII students in the first year and 60 grade VII and 60 grade VIII students during the second year. These investigations took place at Parkallen Junior High School in Edmonton, and involved content from both the grade VIII science program authorized in 1962, and the Nuffield Biology

program for the grade VII level.

In addition, the writer reviewed the scientific and pedagogical literature for projects possibly suitable for students at this level. No attempt at formal evaluation of any of the procedures was undertaken in this study.

CHAPTER V

ANALYSIS OF INTERVIEW DATA

I. PRESENT USE OF MAMMALS IN RELATION TO SELECTED TEACHER CHARACTERISTICS

Of the 30 teachers interviewed, six used live mammals in their classrooms during the period from September 1 to December 31, 1968, representing 20 percent of the sample. Two of these teachers used feral species, which represents seven percent of the sample.

The use of live mammals in the classroom by the various sub-groups in terms of numbers and percentages is shown in Table III. Significance of differences in the use of live mammals according to sub-groups are shown in Table IV.

Significance of Differences Between Sub-groups

No significant differences existed between the sexes of the teachers in relation to the use of live mammals in classroom teaching. The small number of females in the sample and the low probability value limited conclusions in this regard.

There appears to be a relationship (Table III) between the utilization of live mammals and whether or

TABLE III

USE OF LIVE MAMMALS IN RELATION TO TEACHER CHARACTERISTICS

TEACHER CHARACTERISTICS			USED MAMMALS		DID NOT USE MAMMALS	
			Number	Percent	Number	Percent
1.	SEX OF TEACHER	Male	5	22.7	22	77.3
		Female	1	33.0	2	67.0
2.	BIOLOGY METHODS	Taken	3	42.9	4	57.1
		Not taken	3	13.0	20	87.2
3.	NUMBER OF UNIVERSITY BIOLOGY COURSES	0	1	8.3	11	91.7
		1	0	0.0	4	100.0
		2	1	33.0	2	67.0
		3	1	33.0	2	67.0
		4	0	0.0	2	100.0
		6	1	50.0	1	50.0
		7	1	50.0	1	50.0
		9	1	50.0	1	50.0
		12	0	0.0	1	100.0
4.	YEARS OF EXPERIENCE TEACHING SCIENCE VII	1	3	33.0	6	67.0
		2	2	29.0	5	71.0
		3	1	25.0	3	75.0
		4-7	0	0.0	6	100.0
		9-12	0	0.0	4	100.0

TABLE IV

SIGNIFICANCE OF DIFFERENCES BETWEEN SUB-GROUPS IN USE OF SMALL LIVE MAMMALS

TEACHER CHARACTERISTICS	TEST	DIFFERENCE
1. Sex	x^2	not significant
2. Biology Methods Course(s) Taken	x^2	not significant
3. Number of University Biology Courses	r_{pbi}	significant ($.05<p<.10$)
4. Number of Years Experience With Science VIII	r_{pbi}	significant ($p=.05$)

x^2 refers to chi-square test

r_{pbi} refers to point biserial correlation

not a course (or courses) in biology teaching methods was taken by the teacher. A greater percentage of teachers with a methods course used mammals in the classroom. However, no significant difference exists between the two groups.

A low positive correlation ($.05 < p < .10$) occurred between the number of university biology courses taken and live mammal teaching (Table IV).

A negative correlation ($p < .05$) was found to exist between the number of years experience teaching grade VIII science and the use of living mammals in the classroom (Table IV). As the table shows, those teachers in the sample which used live mammals in the classroom had three years, or less, experience with the grade VIII science course.

Summary

According to the analysis of the data concerning the relationships between certain teacher characteristics and the use of live mammals in the classroom, the following statements may be made:

1. Sex of the teacher does not appear to be a factor in whether or not live mammals are used in the classroom. Because of the small number of female teachers involved, however, no definite conclusions may be drawn.

2. There appears to be some relationship, though not statistically significant, between the fact that a teacher had had a course in biology teaching methods and whether or not mammals were used. Those having such a course appear to be more likely to use them.
3. There exists a low significant positive correlation between the number of university biology courses and the use of live mammal teaching.
4. There appears to be a significant negative correlation between the number of years of experience teaching science VIII and the use of small live mammals in the classroom.

II. SMALL MAMMALS USED IN THE CLASSROOM

Of the thirty teachers interviewed, six, or twenty percent, were found to have used live mammals in their classrooms. A breakdown of the numbers and percentages of teachers using each species is shown in Table V. White mice were used most extensively. The only native species used were bats and "field mice", the latter including voles and mice in the case of one teacher.

Table VI indicates the number of individuals and the duration of classroom maintenance for each species

TABLE V

LIVE SMALL MAMMALS USED IN THE CLASSROOM

SPECIES	TEACHERS USING THEM Number	Percentage
White mice	5	17
Tame rabbits	3	10
Cats	2	7
Bats	2	7
"Field mice"	2	7
Dogs	2	7
Hamsters	1	3
Guinea pigs	1	3
Gerbils	1	3

TABLE VI

NUMBER OF INDIVIDUALS AND DURATION OF CLASSROOM MAINTENANCE FOR EACH SPECIES USED

Teacher	White Mice	Tame Rabbits	Cats	Bats	Hamsters	Guinea Pigs	Gerbils	"Field Mice"	Dogs
	No. Time	No. Time	No. Time	No. Time	No. Time	No. Time	No. Time	No. Time	No. Time
1	30 2mo.	1 ½dy.	2 ½dy.						1 ½dy.
2	6 6mo.			1 1mo.				4 6mo.	
3	3 6mo.								
4		2 2wk.			1 1wk.				
5	20 2mo.	2 6mo.	2 3dy.	3 3wk.		1 5mo.	2 8mo.	3 2wk.	1 2dy.
6	1 ½dy.								

used. It was found that of the 30 teachers interviewed, only six had had live small mammals in the classroom all year. The total time that the animals were maintained in the classroom was thus recorded, covering a period from September 1, 1968 to April 15, 1969. The animals were kept by the teachers for periods varying from half a day to eight months. Their numbers ranged from one to thirty per classroom.

The interview question which asked how and where the live mammals were obtained revealed, in all cases, that the pupils were responsible for bringing the animals to school. The bats and field mice were caught by hand in the wild, while the other animals were domestic animals kept as pets. In all instances, the pupils were responsible for the complete care of the animals.

The maintenance techniques used by the teachers who kept animals in the classroom are shown in Table VII. The maintenance question was not applicable in two instances when one teacher used white mice and another used tame rabbits for only half a day (Table VI). The cats and dogs were not kept in cages and were returned home daily. The white mice used were all kept in commercial animal cages. All of the other species were housed in adapted and home-made cages. For a description of the cages, see Appendix IV. Many of the animals were fed improvised diets, although commercial

TABLE VII

MAINTENANCE TECHNIQUES USED BY TEACHERS INTERVIEWED

SPECIES	PROPORTION OF TEACHERS USING VARIOUS TECHNIQUES					
	CAGES			DIET		
	Commercial		Home-made	Commercial		Improvised
	Specific	Adapted		Specific	Adapted	
White mice*	4/4				2/4	2/4
Tame rabbits*			2/2	1/2		1/2
Bats		2/2				2/2
"Field Mice"		1/2	1/2	1/2		1/2
Hamsters		1/1		1/1		
Guinea pigs			1/1	1/1		
Gerbils			1/1	1/1		
Cats**						
Dogs**						

*One teacher in each instance did not keep the animals in the classroom for longer than one-half day.

**These two species were not caged, and were taken home nightly for feeding.

animal foods were used almost as extensively. For description of the diets fed to these animals see Appendix V.

The proportion of teachers attempting to breed the animals, and the consequent success is seen in Table VIII. Most of the teachers did not attempt to breed the animals, except for the white mice. The white mice bred successfully. One teacher tried unsuccessfully to breed gerbils.

Table IX indicates the responses to two questions which dealt with the advantages and problems related to the presence of live small mammals in the classroom. The teachers concerned were especially emphatic in their opinion that the animals greatly stimulated student interest and encouraged further study. They stated that the animals were useful as subjects for illustration of concepts and also provided the opportunity for students to learn how to handle and care for them.

The other question dealing with difficult problems associated with the presence of small live mammals in the classroom resulted in an emphatic negative response from all of the teachers involved. However, some of the teachers stated that some minor disadvantages exist, these being: complaints from other teachers, smell, students occasionally forgetting to feed the animals over the weekends, and the occasional escape of the animals.

TABLE VIII

BREEDING SUCCESS OF ANIMALS IN THE CLASSROOM OF INTERVIEWED TEACHERS

SPECIES	PROPORTION OF TEACHERS		
	ATTEMPTED TO BREED THE ANIMALS		DID NOT ATTEMPT TO BREED THE ANIMALS
	SUCCESSFUL	UNSUCCESSFUL	
White mice	3/5		2/5
Tame rabbits			3/3
Bats			2/2
"Field mice"			2/2
Hamsters			1/1
Guinea pigs			1/1
Gerbils		1/1	

TABLE IX

ADVANTAGES AND DISADVANTAGES TO HAVING LIVE MAMMALS IN THE CLASSROOM

	ADVANTAGES				DISADVANTAGES				
Teacher	Can be used for illustration purposes	Creates interest	Motivates further study	Provides opportunity for learning about animal care	Complaints from other teachers	Students forget to feed animals over week end	Smell	Animals escape on occasion	None
1		X			X			X	
2	X	X		X		X	X		
3		X					X	X	
4	X	X	X	X					X
5			X						X
6	X		X						X
Totals	3	4	3	2	1	1	2	2	3

The live animals were used in several ways in the classrooms, as is shown in Table X. Only one teacher used the animals for display purposes alone. The others used the animals to illustrate a limited number of concepts as can be seen from the table. In all cases, each concept was illustrated by one activity.

III. TEACHERS' OPINIONS ON USE OF FERAL MAMMALS

When the teachers were asked why native small mammals might not be used extensively in Alberta classrooms, they gave many reasons (Appendix VI). These were categorized by the writer into seven groups and the number and percentages of teachers giving each response is given in Table XI. Each teacher gave an average of two responses. By far the most common reason was that the use of feral mammal species required extra teacher involvement. Almost half the teachers cited lack of facilities as a reason. Five teachers felt that live mammals would be generally inconvenient. Four felt that legal and humane aspects precluded feral species in captivity. Four also stated that the study of mammals was too advanced for, or inappropriate to, the grade VIII science program. Two teachers felt that other methods were superior.

Table XII shows the numbers and percentages of

TABLE X

PURPOSES TO WHICH LIVE MAMMALS WERE PUT IN CLASSROOMS

	PURPOSES								
Teacher	Reproduction and growth	Conditioning	Feeding habits and diet	General behavior	Structure	Locomotion	Effect of drugs on behavior	Display	Total number of uses by each teacher
1	X	X	X						3
2		X		X	X		X		4
3								X	1
4			X	X					2
5					X	X			2
6					X				1
Total	1	2	2	2	3	1	1	1	

TABLE XI

REASONS GIVEN FOR NOT USING LIVE FERAL MAMMALS IN THE CLASSROOM

Reason	Response Given	
	Number of Teachers	Percent of Teachers
1. Extra teacher involvement required	23	77
2. Lack of facilities	14	47
3. Lack of teacher knowledge	9	30
4. General inconvenience	5	17
5. Legal and humane aspects	4	13
6. Study of mammals too advanced or inappropriate at this level	4	13
7. Other methods superior	2	8

TABLE XII

NATIVE SMALL MAMMALS SUGGESTED FOR STUDY BY TEACHERS

Kind	Response Given	
	Number of Teachers	Percent of Teachers
1. Mice	16	53
2. Rabbits	12	40
3. Gophers	10	33
4. Ground squirrels	5	17
5. Rats	5	17
6. Tree squirrels	5	17
7. Porcupines	3	10
8. Chipmunks	3	10
9. Voles	2	8
10. Shrews	1	3
11. Flying squirrels	1	3
12. Bats	1	3
13. Muskrats	1	3
14. Skunk	1	3

teachers suggesting various native mammal species for study. The most frequently cited species were mice, rabbits and gophers. On the average, each teacher gave two examples. Most of the species cited were rodents, with the exception of rabbits, bats, shrews and skunks.

Responses to the final question concerning the purposes for which teachers feel that feral mammals may be used are summarized in Table XIII. The actual responses in each category are given in Appendix VII. Sixty percent of the teachers suggested that feral small mammals could be used in the study of structure and ecology, including adaptations to environment. The other possibilities were less frequently given, by fewer than one-third of the teachers. These included the study of reproduction, behavior and metabolism. Only seven teachers felt that live feral species could be used to create student interest. Four teachers were of the opinion that feral animals could be utilized for teaching animal care. Only three indicated that native species might be used for teaching species recognition.

Summary

The results of the interview questions indicate a small percentage of teachers in the city of Edmonton use live small mammals in the grade VIII science classroom. The following information on actual utilization was obtained:

TABLE XIII

REASONS GIVEN FOR USING LIVE FERAL MAMMALS IN THE CLASSROOM

Reasons	Response Given	
	Number of Teachers	Percent of Teachers
1. To study structure	18	60
2. To study ecology	18	60
3. To study reproduction	9	30
4. To study behavior	8	27
5. To create student interest	7	23
6. To learn care of pets	4	13
7. To study metabolism	4	13
8. To recognize local fauna	3	10

1. As a whole, the number of species and individuals used was limited, with most being domestic.
2. Pupils were responsible for bringing in and caring for all small live mammals in the classrooms.
3. The animals were kept in the classroom for varying periods of time.
4. A wide variety of maintenance techniques was utilized.
5. In most cases, no attempt was made to breed the animals. White mice were bred successfully by several of the teachers.
6. The presence of live small mammals in the classroom was found to be most advantageous in creating student interest. Few disadvantages, felt to be minor ones by the teachers, were found to exist.
7. The animals were used in a limited variety of ways, and at most, were used to illustrate four concepts.

The balance of the information obtained from the interviews was received from the entire sample. Briefly, it can be summarized as follows:

1. The two most frequently given reasons for the possible limited use of feral mammal species

was the extra teacher involvement required and lack of facilities, in that order.

2. Mice, rabbits and gophers were the most frequently suggested feral species for classroom study.

3. The most common suggestions given by interviewed teachers for the use of feral mammals were for the study of structure, ecology and behavior. Fewer teachers suggested that they be used to create interest and to teach animal care. A few teachers suggested that feral species be used for the study of metabolism and for species recognition.

III. DISCUSSION

It appears from the interview results that Edmonton grade VIII science teachers with limited experience (less than three years) and an extensive background in biology are most likely to utilize live mammal teaching, but even in these cases, not extensively. It is not possible at this time to explain why this is so. It may be that recent graduates from the university have been trained in the new philosophy of science education. It is also possible that experienced teachers who hold with the present trend in curriculum development are involved in pilot projects and thus were not part of the population

sampled, leaving those unwilling or unable to attempt new techniques of instruction. It would appear necessary to encourage most teachers to do so if the new life science program at this level is to be initiated and executed successfully.

The writer feels that many of the reasons given by the interviewed teachers for not using feral mammals in the classroom (Appendix VI) may be questioned or refuted. For example, many teachers felt that their use requires extra involvement by the teacher, such as care on week-ends. However, the teachers who did use feral and domestic mammal species in their classrooms found that pupils brought the animals and cared for them successfully on their own. None of the animals required elaborate equipment for their collection or maintenance.

Many teachers thought that they did not have the time or knowledge to develop activities which utilize live mammals. The writer supports Jacknicke's (1968) thesis that resource materials providing such information will probably overcome such difficulties.

Some teachers expected that live mammals in the classroom would be a nuisance. These anticipated inconveniences did not occur in the classrooms of those teachers using animals. In fact, the latter emphatically stated that the presence of animals provided no serious difficulties.

The writer feels that legal and humane problems need not arise in regard to capturing feral species. Firstly, many feral rodents are considered to be vermin. Secondly, to be completely pragmatic, animals generally live longer in captivity than in the wild because they can be provided with a well-balanced diet *ad libitum*, whereas in the wild there generally are periods of food scarcity. Also, the danger of predation is eliminated. The writer has kept voles and mice in captivity for more than two years, whereas this lifespan is very rarely achieved in the wild. With feral species, it is possible to allow animals to return to their habitat after they have been studied, and to expect the animals to resume normal lives in the wild, providing the period of captivity was not too long. Finally, the writer believes that the learning of proper handling and respect for the animals gained by the student under teacher direction is more beneficial to animals in the long run than is their immediate freedom.

Several teachers considered the study of mammals too advanced or inappropriate at this level. Perhaps these teachers are unaware of simple activities of wide significance that could be effectively used. This opinion is supported by those teachers who have employed such activities.

Finally, two teachers stated that other methods,

such as the use of pictures or field trips to the natural environment, are superior to having live mammals in the classroom. First, live mammals are seldom seen on field trips to their natural habitats. Secondly, Bruner (1960) points out that a variety of techniques are desirable in instruction and thus, the study of live wild mammals could be used profitably in conjunction with other techniques.

The reasons given by teachers for using feral mammal species seemed to emphasize content. For example, although the teachers who used live animals in the classroom stressed the motivational aspect of this method, few of the total population gave this reason for their use. Only one teacher suggested that living organisms are a necessary part of life sciences. None suggested that they be used to illustrate science processes, although some teachers did have students carry out research projects involving live mammals.

Only three teachers indicated that live feral mammals could be used to teach students recognition of native fauna through actual experience with the animals. Perhaps most teachers did not feel that species recognition is an important objective in the life sciences at this level.

Finally, the limited number (two each) of native mammal species that were suggested by the interviewed

teachers, and the fact that most of the teachers who suggested gophers for study were unable to clearly describe the animal (many were probably referring to Richardson's ground squirrel), would indicate that the teachers, on the whole, are not aware of the wide variety of feral organisms available for classroom use.

It seems fair to say, in summary, that Edmonton grade VIII science teachers do not use live mammals, particularly feral species, to any great extent. This study supports the findings of Jacknicke (1968) in Lacombe County and of Abbott (1954) in the United States. The writer feels that this could be partially overcome by providing information to teachers which would enable them to attempt the use of local resources without adding appreciably to the burden of their teaching duties.

CHAPTER VI

TECHNIQUES OF COLLECTION AND MAINTENANCE OF THE RED-BACKED VOLE AND DEERMOUSE

INTRODUCTION

There is a great deal of information available in the literature on collection and maintenance of the two rodents under consideration. For the purposes of the classroom teacher in Alberta, however, much of the information is either too general, inappropriate or relatively inaccessible. Furthermore, Hurd (1961) expresses the opinion that too often teachers are unable to undertake new procedures because directions are not sufficiently detailed. Thus, this chapter is an attempt to provide some specific information on expedient procedures for the collection and care of the red-backed vole and deermouse in this province. The first section of this chapter will deal with collection and the second with maintenance of the animals.

COLLECTION

The rodents were trapped over a period of five years, from November 12, 1964 to September 29, 1969 in areas of the Northwest Territories with vegetative

characteristics similar to those of much of Alberta, and also in areas in Alberta, primarily in the immediate vicinity of the city of Edmonton (Table XIV).

Analysis of Trapping Results

Table XV shows the trapping success for the deer-mouse and red-backed vole according to habitat category described previously in Chapter IV. Preliminary examination of this data indicates that deermice were collected in all areas save one (sphagnum bog), and voles were obtained only in the wooded areas with the exception of parklike-jackpine.

Deermice were obtained in great numbers from the farmyard habitat. Trapping success from this area was significantly greater than that of the roadside habitat ($p < 0.005$), and that of all the others ($p < 0.001$). The roadside habitat, in turn, yielded the second greatest success for deermice and was significantly greater than that of jackpine-juniper, white spruce, and poplar ($p < 0.001$), sphagnum bog ($p < 0.005$), and parklike-jackpine and old field ($p < 0.02$). The success of the roadside area was not significantly greater than that of the spruce-poplar area. The third best yield of deermice came from the white spruce-poplar habitat. It produced significantly more animals than white spruce and sphagnum habitats ($p < 0.005$) and the poplar habitat

TABLE XIV: TRAPPING RESULTS

DATE	LOCATION	DESCRIPTION	Trap Type	Traps Set	TRAPPING RESULTS		
					P.m.[1]	C.g.[2]	Other
					No.(%)[3]	No.(%)	No.(%)
Nov. 12, 1964	Rycroft	Stubble Field	ST[4]	10	6(60.0)	0(0)	0(0)
Nov. 12, 1964	Rycroft	Under Granary	ST	10	5(50.0)	0(0)	0(0)[5]
Sept.18, 1965	Hastings Lake	Poplar	ST	100	2(2)	3(3)	1(1)
Sept.25, 1965	Big Island Lake	Sphagnum Bog	ST	100	0(0)	14(14)	0(0)
Oct. 2, 1965	Cooking Lake	Grassland-Pasture	ST	100	0(0)	0(0)	3(3)[5]
Oct. 9, 1965	Ed.[6] (Riverbank)	White Spruce	ST	100	0(0)	3(3)	0(0)
Mar. 19, 1966	Ellerslie	Haystack	H[7]	-	-	1(-)	6(-)
May 24, 1966	Hart Lake,N.W.T.	Sphagnum Bog	ST	40	0(0)	0(0)	0(0)
May 25, 1966	Hart Lake,N.W.T.	Poplar	ST	40	0(0)	1(2.5)	0(0)
May 27, 1966	Hart Lake,N.W.T.	Jackpine-Juniper	ST	40	1(2.5)	0(0)	0(0)
July 25, 1966	Hart Lake,N.W.T.	White Spruce	ST	40	7(17.5)	0(0)	0(0)
Oct. 15, 1966	Hart Lake,N.W.T.	White Spruce	ST	40	2(5.0)	3(7.5)	0(0)
Oct. 16, 1966	Hart Lake,N.W.T.	Park-like Jackpine	ST	40	3(7.5)	0(0)	0(0)
Nov. 22, 1966	Hart Lake,N.W.T.	Jackpine-Juniper	ST	40	0(0)	3(7.5)	0(0)
Nov. 26, 1966	Hart Lake,N.W.T.	Parklike Jackpine	ST	40	0(0)	0(0)	0(0)
Nov. 26, 1966	Hart Lake,N.W.T.	Poplar	ST	40	0(0)	2(5.0)	0(0)
Dec. 2, 1966	Hart Lake,N.W.T.	White Spruce	ST	40	0(0)	1(2.5)	0(0)
Dec. 2, 1966	Hart Lake,N.W.T.	Sphagnum Bog	ST	40	0(0)	2(5.0)	0(0)
Dec. 13, 1966	Hart Lake,N.W.T.	Jackpine-Juniper	ST	40	0(0)	0(0)	0(0)
Dec. 15, 1966	Hart Lake,N.W.T.	White Spruce	LT[8]	40	0(0)	3(7.5)	0(0)
Dec. 15, 1966	Hart Lake,N.W.T.	Poplar	ST	40	0(0)	1(2.5)	0(0)
Dec. 15, 1966	Hart Lake,N.W.T.	White Spruce	LT[8]	60	0(0)	1(1.6)	0(0)
Dec. 16, 1966	Hart Lake,N.W.T.	White Spruce	LT	60	0(0)	4(6.7)	0(0)
Dec. 17, 1966	Hart Lake,N.W.T.	White Spruce	LT	60	1(1.6)	0(0)	0(0)
Jan. 8, 1967	Hart Lake,N.W.T.	Jackpine-Juniper	ST	40	0(0)	0(0)	0(0)
Jan. 8, 1967	Hart Lake,N.W.T.	Poplar	ST	40	2(5.0)	0(0)	0(0)

TABLE XIV (continued)

DATE	LOCATION	DESCRIPTION	Trap Type	Traps Set	TRAPPING RESULTS P.m. No.(%)	C.g. No.(%)	Other No.(%)
Jan. 9, 1967	Hart Lake, N.W.T.	Park-like Jackpine	ST	40	0(0)	0(0)	0(0)
Jan. 10, 1967	Hart Lake, N.W.T.	Poplar	ST	40	0(0)	2(5.0)	0(0)
Jan. 10, 1967	Hart Lake, N.W.T.	Sphagnum Bog	ST	40	0(0)	0(0)	0(0)
Jan. 27, 1967	Hart Lake, N.W.T.	Poplar	LT	30	0(0)	0(0)	0(0)
Jan. 28, 1967	Hart Lake, N.W.T.	Poplar	LT	30	0(0)	0(0)	0(0)
Jan. 29, 1967	Hart Lake, N.W.T.	White Spruce	LT	50	0(0)	1(2.0)	0(0)
Jan. 30, 1967	Hart Lake, N.W.T.	White Spruce	LT	50	0(0)	0(0)	0(0)
Jan. 31, 1967	Hart Lake, N.W.T.	White Spruce	LT	50	0(0)	3(6.0)	0(0)
Feb. 1, 1967	Hart Lake, N.W.T.	Poplar	LT	30	0(0)	0(0)	0(0)
Feb. 5, 1967	Hart Lake, N.W.T.	White Spruce	LT	50	1(2.0)	2(4.0)	0(0)
Mar. 4, 1967	Hart Lake, N.W.T.	White Spruce	LT	50	1(2.0)	1(2.0)	0(0)
Apr. 16, 1967	Hart Lake, N.W.T.	Jackpine-Juniper	ST	40	4(10.0)	0(0)	0(0)
Apr. 18, 1967	Hart Lake, N.W.T.	Jackpine-Juniper	ST	40	0(0)	1(2.5)	0(0)
May 8, 1967	Hart Lake, N.W.T.	White Spruce	LT	40	1(2.5)	4(10.0)	0(0)
June 19, 1967	Hart Lake, N.W.T.	Poplar	ST	40	3(7.5)	0(0)	0(0)
Oct. 15, 1967	Ed. (Riverbank)	Poplar	ST	40	2(5.0)	3(7.5)	0(0)
Sept. 8, 1968	Ellerslie	White Spruce-Poplar	ST	40	1(2.5)	2(5.0)	0(0)
Nov. 16, 1968	Ellerslie	White Spruce-Poplar	ST	40	2(5.0)	6(15.0)	0(0)
Apr. 12, 1969	Ellerslie	White Spruce-Poplar	ST	40	1(2.5)	1(2.5)	0(0)
Apr. 12, 1969	Ellerslie	White Spruce-Poplar	LT	34	7(20.6)	3(8.8)	0(0)
June 6, 1969	Ellerslie	Abandoned Farmstead	ST	20	16(80.0)	0(0)	1(5.0)[9]
June 9, 1969	Ellerslie	Grassy Ditch	ST	20	5(25.0)	0(0)	5(20.0)[10]
June 10, 1969	Ellerslie	White Spruce-Poplar	LT	34	5(14.7)	2(5.9)	0(0)
June 10, 1969	Ellerslie	White Spruce-Poplar	ST	20	1(5.0)	1(5.0)	0(0)
July 8, 1969	Ellerslie	Grassland (Pasture)	ST	20	1(5.0)	0(0)	0(0)
July 8, 1969	Ellerslie	Grassland (Pasture)	H	-	-	-	7(-)[5]

TABLE XIV (continued)

DATE	LOCATION	DESCRIPTION	Trap Type	Traps Set	TRAPPING RESULTS		
					P.m.	*C.g.*	Other
					No.(%)	No.(%)	No.(%)
July 10, 1969	Ellerslie	RR Right-of-way	ST	20	4(20.0)	0(0)	7(35.0)[11]
July 11, 1969	Ellerslie	White Spruce-Poplar	ST	20	5(25.0)	1(5.0)	1(5.0)[12]
July 12, 1969	Ellerslie	White Spruce-Poplar	ST	20	12(60.0)	6(30.0)	0(0)
July 13, 1969	Ellerslie	Grassy Ditch	ST	20	8(40.0)	0(0)	8(40.0)[5]
July 18, 1969	Ellerslie	White Spruce-Poplar	LT	50	17(34.0)	2(4.0)	0(0)
July 19, 1969	Ellerslie	White Spruce-Poplar	ST	34	4(11.8)	4(11.8)	2(5.9)[5]
July 29, 1969	Ed.[6] (Riverbank)	Poplar	ST	40	2(5.0)	0(0)	0(0)
July 29, 1969	Ed.[6]	Grassy Vacant Lot	ST	20	0(0)	0(0)	1(5.0)[5]
Aug. 2, 1969	Ellerslie	Grain Elevator	ST	20	14(70.0)	0(0)	6(30.0)[9]
Sept.19, 1969	Ed.[6]	Horse Barn	ST	20	14(70.0)	0(0)	6(30.0)[9]
Sept.23, 1969	Ed.[6]	Horse Barn	ST	20	10(50.0)	0(0)	9(45.0)[9]

1. *P.m.* - *Peromyscus maniculatus*
2. *C.g.* - *Clethrionomys gapperi*
3. Percentage rounded to one decimal
4. ST - Snap-trapped
5. *Microtus pennsylvanicus*
6. Ed. - Edmonton
7. H - Hand-trapped
8. LT - Live-trapped
9. *Mus musculus*
10. 4 *M. pennsylvanicus*; 1 *M. musculus*
11. 6 *M. pennsylvanicus*; 1 *Sorex sp.*
12. *Eutamius minimus*

TABLE XV

MEAN TRAPPING SUCCESS FOR THE TWO RODENTS ACCORDING TO HABITAT TYPE

The sample number is shown in parentheses

AREA TRAPPED	Percent Success	
	P. maniculatus	*C. gapperi*
Parklike Jackpine	2.5±2.5*(3)	0±0(3)
Jackpine-Juniper	2.1±1.6(6)	1.7±1.2(6)
White Spruce	2.2±0.7(14)	3.7±0.9(14)
Sphagnum Bog	0±0(4)	4.8±3.3(4)
Poplar	2.2±0.9(11)	2.3±0.8(11)
White Spruce-Poplar	18.1±5.7(10)	9.3±2.6(10)
Roadside	28.3±6.0(3)	0±0(3)
Farmyard	63.3±4.9(6)	0±0(6)
Old Field	1.7±1.7(3)	0±0(3)

* ± standard error

($p < 0.01$) but not significantly more than the jackpine-juniper, parklike-jackpine or old field habitats. No other significant differences in success exist in the data.

Most red-backed voles were obtained from the white spruce-poplar habitat--significantly more only in the case of poplar and farmyard habitats ($p < 0.05$), and the white spruce habitat ($p < 0.05$). The next highest percentage yield of voles was obtained from the sphagnum bog but no significant differences were found to exist. The yields from the white spruce and poplar forests were significantly greater ($p < 0.02$ and $p < 0.05$ respectively) than that of the farmyard. No other significant differences accrued from the data.

In comparing the yield of the deermice and voles from each habitat, more deermice than voles were obtained from six of the habitats (parklike-jackpine, jackpine-juniper, white spruce-poplar, roadside, farmyard, and old field). However, the differences in the yield were found to be significantly greater for deermice only in the roadside ($p < 0.01$) and farmyard ($p < 0.001$) habitats. Voles were obtained in greater numbers from the white spruce and sphagnum bog, and very slightly greater numbers in the poplar habitats. However, none of these values were significantly greater.

In the results being discussed, it is felt that

small sample numbers from some of the habitats were responsible for the lack of significance between fairly large differences in percentage success. Also seasonal differences in results were not accounted for and winter trapping was not carried out in all areas.

<u>Discussion of Trapping Results</u>

From the results it appears that the deermouse, while obtained in a variety of situations, was most successfully captured in the farmyard habitat [in and around farmyards and associated buildings (grain elevator)]. Edge areas (roadside habitat) and the spruce-poplar areas also yielded good returns. Two observations might be made on these results: deermice seemed to prefer disturbed areas (i.e. by farming activities), and those areas providing scant cover. Cover in these areas varied from poor to fair. Even when cover was fair, it was noted that the mice were trapped in relatively open areas. The literature supports both these observations. Tevis (1956), LoBue and Darnell (1959) and Hoffman (1955) all found that logging, farming, and garbage dumping activities, respectively, produced habitats favored by deermice. Sharp (1965), Whitaker (1966, 1967), LoBue and Darnell (1959), and Hoffman (1955) all commented that deermice require little cover.

Voles were found to prefer wooded areas, all with variable cover (poor to very good). All the areas which yielded the voles had some cover and it was observed, at the time of collection, that the animals were indeed trapped in those areas. These observations are supported by the findings of Gunderson (1959) who reported that the distribution of C. gapperi was correlated with the presence of stumps, rotting logs and root systems in loose forest litter and sphagnum. Tevis (1956) found that after logging of douglas fir, red-backed voles trapped were found in close association with logs. Studies by Soper (1946), Butsch (1954), Gunderson (1959), Clough (1964), Cameron (1964), Morris (1969) and Sharp (1965) support the results of this study, indicating that Clethrionomys inhabit wooded areas, preferably coniferous.

From the results of trapping then, it appears that deermice might best be obtained in disturbed areas with minimal cover, whereas a wooded area with fair cover is best for obtaining voles. If both species are desired, trapping in a mixed forest of white spruce and poplar would likely produce the desired results.

At this point it is necessary to discuss the effect of weather conditions on trapping results. Snow conditions greatly decreased the yields. Summer meteorogical conditions did not seem to affect the results

except when strong rain fell, setting off some of the snap-traps. Gentry, Golley and McGinnis (1966) in Georgia found that the habitat type and the day in the three-day trapping sequence had a greater effect on the success than change in weather, although it does have some effect. This is supported by Kalela (1957) in his work on C. glareolus in Finland.

As was previously mentioned, setting traps in the winter snows not only yielded few captures but also it was difficult to set the traps. In addition, live-trap mortality was a problem. As was described in the section on methods, procedures of setting traps in the winter snows were modifications of summer trapping techniques. It is the opinion of the writer that if the purpose of trapping is to obtain as many animals as possible, it is preferable to do this before or after winter snows, or within farm buildings in the case of deermice. Voles are sometimes available in hay or straw stacks (loose or baled), although the numbers to be expected are low.

Snow, however, is present in most parts of Alberta for a great portion of the school year. In addition to those used in this study, there are several methods suggested by the literature for placement of traps, bait, and ways to reduce trap mortality in live-traps. Soper (1944) suggested that snap-traps should be pre-baited (with the same bait used in the summer) and placed in

early winter on the snow surface near tunnel openings, under logs and windfalls, or at the bottom of trenches covered by boughs (in forests and bogs). When the snow was less than a foot deep, he placed traps on snowshoe and toboggan trails. Pruitt (1959) and MacKay (1962) found traps at ground level to be more successful. To trap taiga animals, Pruitt (1959) used trap chimneys made of 5/8 inch plywood with hinged lids and with one side four inches shorter than the other three sides. Fay (1960), faced with problems of drifting snow while trapping small mammals in the tundra, used old oil drum chimneys set up similarly to Pruitt's plywood ones. MacKay (1962), after finding that the small mammals in his study area generally confined their activities to natural air pockets formed under windfalls, brush and slash, set traps at the ground level near debris and covered the trap site at the snow surface with corrugated cardboard sheets.

Reducing live-trap mortality was somewhat difficult. The nest material of Terylene, although it did not absorb moisture as cotton wool would, did get covered by urine which froze. This was also the experience of Pruitt (1959) who felt that the effect of the frozen urine on the animal was more detrimental than the cold due to the absence of the material. He felt that a good supply of food in the traps and constant attention

was better than relying on nesting material for survival of the animals. Howard (1949, 1951) and Chitty (1938) supported Pruitt's opinion on the necessity of an abundance of food in the trap during cold weather.

Miller and Getz (1968) insulated their live-traps with plastic tubing wrapped in cotton in a method similar to that used in this study. With the ambient temperatures varying from -10° C to -4° C overnight, the mortality was only 1.5% when the traps were checked twice daily.

In regard to trap mortality, there are also other factors that could be considered. Platt (1968) made the observation that excessive trap mortality for *P. maniculatus* and *C. gapperi* was associated with periods of population decrease, whereas mortality was less than expected during periods of increase.

An attempt was made to compare the overall success of the Sherman and Longworth traps, as well as the mortality rate, over a short period of time in the white spruce-poplar habitat (Table XVI). Although no significant differences were found (t-test) possibly due to the small sample number, the results would seem to indicate a tendency for Sherman traps to capture more animals than the Longworth, which is supported by Morris' study (1968) which showed a significantly definite preference for Sherman traps. Quast and Howard (1953) found that

TABLE XVI

COMPARISON OF PERCENT SUCCESS OF SHERMAN AND LONGWORTH TRAPS

DATE	SHERMAN		LONGWORTH	
	Percent Success	Mortality	Percent Success	Mortality
April 12, 1969	80.0	25.0	16.7	0.0
June 10, 1969	20.0	100.0	20.9	20.0
July 18, 1969	50.0	0.0	35.0	0.0
July 19, 1969	20.0	100.0	33.3	50.0
$\overline{X}$	42.5 ± 14.3(4)	56.3 ± 25.8(4)	26.5 ± 4.5(4)	17.5 ± 11.8(4)

when using Sherman traps of two sizes (3 x 3 x 10 inches and 2 x 2.5 and 6.5 inches) the larger were more successful for P. maniculatus. The data indicated that the mortality rate for Sherman traps is greater than for Longworth, but not significantly.

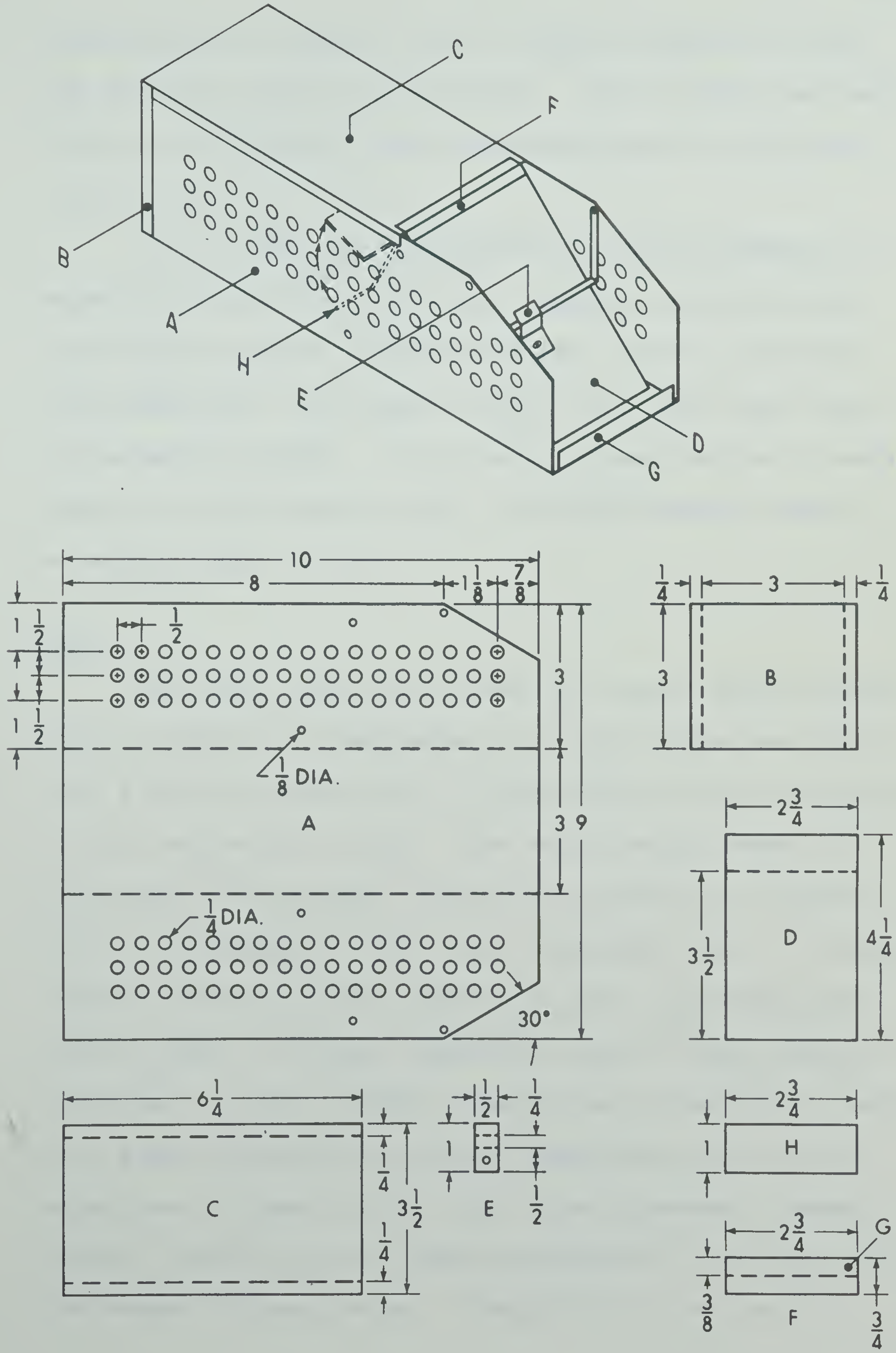
Although no attempt was made to compare the relative success of snap- or live-traps, Sealander and James (1958) found that snap-traps were relatively inefficient as compared with live-traps. This bodes well for the teacher attempting to obtain live animals for the classroom.

Thus far the discussion of traps has been limited to the use of those commercially produced. It does not seem economical to the writer to produce home-made snap-traps, as Museum Special traps are inexpensive. Victor mouse traps, cheaper and obtainable in hardware stores, could be used in their stead, even though they are smaller.

Live-traps are more expensive and thus it might be advisable to produce them oneself. One of the writer's eighth grade students, Gary Feir, constructed a fairly sophisticated trap for which he drafted his own plans (Figure 3) as a project in his Industrial Arts class.

There are many types of less sophisticated equipment that can be made from inexpensive materials as

Figure 3. Plans of a Student Designed Live-trap (with permission from Gary Feir).



C
F
B
A
H
E
D
G
10
8
1 1/8
7/8
1 1/2
1/2
1 1/2
3
1/8 DIA.
A
3
9
1/4 DIA.
30°
1/4
3
1/4
3
B
2 3/4
3 1/2
D
4 1/4
6 1/4
1/4
C
3 1/2
1/4
1/2
1/4
1
E
1/2
2 3/4
1
H
2 3/4
G
3/8
F
3/4

illustrated in Figures 4 and 5, after Scheffler (1934) and Phillips (1964) respectively. Davis (1964) and Hall (1946) both include other detailed plans for live-trap construction.

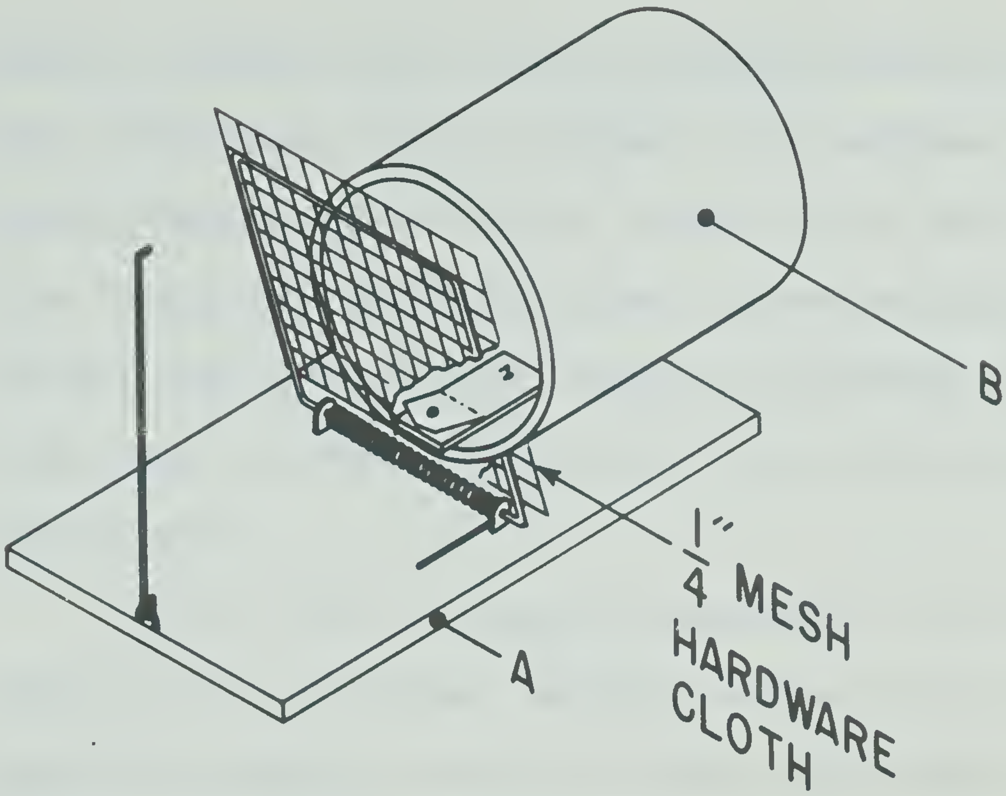
It is also often possible to collect numbers of deermice without traps at all. Pupils can investigate old farm buildings, discarded lumber piles, old boxes, farm machinery, old fodder bales, etc. and often catch the animals by hand. It is well to wear gloves at such times to avoid being bitten, although deermice tend to be surprisingly docile.

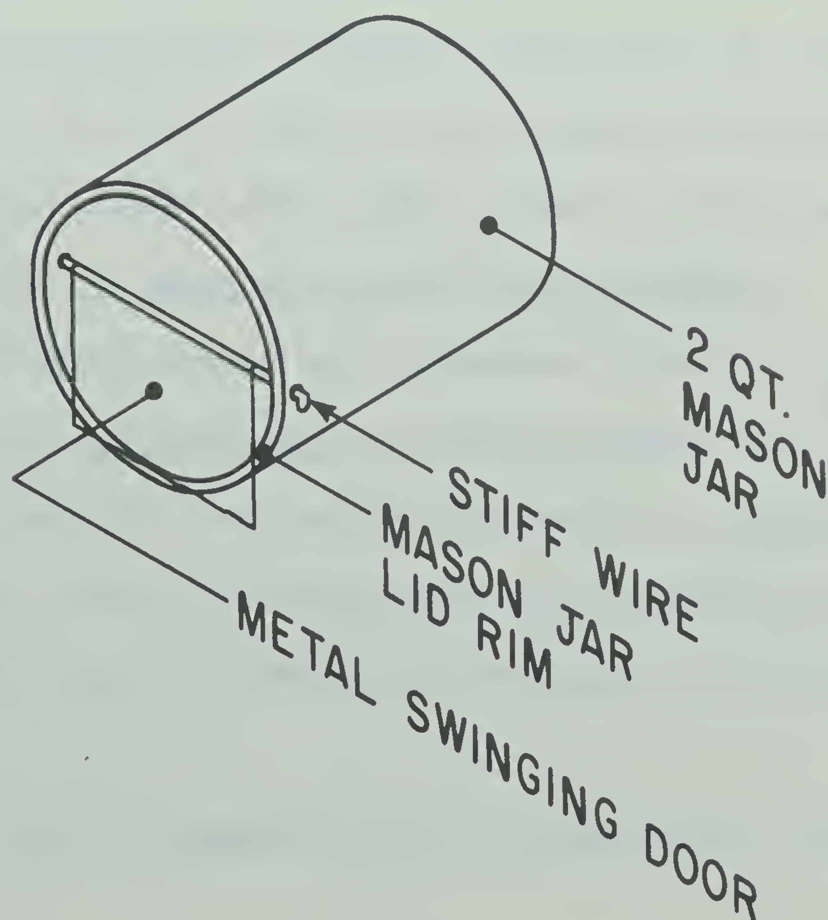
Bait

The bait used was a pound of peanut butter mixed with a couple of teaspoonfuls of bacon grease and about half a cup of rolled oats. A tiny dab of this was applied to the trap with a stick. The bacon grease seems to give more odor and the rolled oats extends the mixture. This is certainly not the only successful bait, as every trapper seems to have a preferred one, although peanut butter seems to be most generally used in this country. According to Davis (1964), studies have shown that there is a great variability in bait preference and a wide acceptance of many baits. G.R. Dyke (personal communication) carried out two minor experiments involving bait preference in snap-traps. Comparison of success of

Figure 4. Scheffler Live-trap (after Scheffler, 1934).
A, snap trap; B, tin can.

Figure 5. Modified Horne Live-trap (after Phillips, 1964).


B
1/4" MESH
HARDWARE
CLOTH
A


2 QT.
MASON
JAR
STIFF WIRE
MASON JAR
LID RIM
METAL SWINGING DOOR

mashed sardines with that of peanut butter indicated some preference for the former. In another comparison, peanut butter baited traps seemed to be less preferable than brand new unbaited traps. These experiments were carried out for only one night of trapping in one vegetation zone, so the results should be accepted only as indications.

Beer (1964) compared preference for twelve baits: simple baits of peanut butter, rolled oats, bacon, limburger cheese, ground raisins, berry jam, raw hamburger, canned sardines and walnut meats, as well as mixtures of peanut butter and rolled oats; peanut butter, rolled oats, ground raisins and bacon fat; and anise oil in a cooking oil carrier. He found the best bait for *Peromyscus leucopus* and *Clethrionomys gapperi* was the peanut butter-rolled oats mixture, followed by the mixture of peanut butter, rolled oats, bacon fat and chopped raisins. He also found that pure peanut butter produced good results for *C. gapperi* and *P. maniculatus*.

Fitch (1954) reported a seasonal change in bait acceptance by *P. maniculatus* in that a grain bait (not identified) seemed to be less acceptable in late spring to late autumn, which he suggested was related to the fact that insects are abundantly available in the habitat at that time.

Davis (1964) suggested some alternative baits

such as raisins, apples, whole oats and bananas. Depending on the bait, these may be pressed onto the treadle or scattered on the trap.

Verts (1961) suggests that a convenient method of carrying and dispensing baits is an ordinary catsup squeeze bottle filled with bait, and the nozzle cut off to provide a hole about 1/4 inch in diameter.

MAINTENANCE

Caging Facilities

The cages used in this study were described in Chapter IV. Of these, the writer preferred the commercially produced plastic cages because they were light, easily cleaned and had convenient accommodations for food and water. In addition, they were relatively inexpensive and durable. Commercially produced wire-mesh cages were found to be less acceptable in that the animals were not easily viewed without opening the cages, they were difficult to clean largely because of their bulk, and those with drop trays seemed uncomfortable to the animal. However, if a teacher has these rodent cages on hand, they could be used to advantage. Wire cages as found in many pet stores are unacceptable in that the deermice, particularly, find ways of escaping from them. Home-made cages were used in this study, but it was found that they had to be carefully

constructed to prevent the animals from escaping. The cages with wooden floors and wire screen sides were found to be difficult to clean, and the urine was soon found to saturate the floor. In the literature there are many plans available which can be followed easily by students. The Animal Welfare Institute (P.O. Box 3492, Grand Central Station, New York, N.Y. 10017) publishes, free of charge, a manual on design and construction of animal quarters and equipment entitled Comfortable Quarters for Laboratory Animals. The quarters designed for mice would be suitable for the wild rodents. The number of animals kept together in any cage was below six and the cage-mates were watched carefully for compatability. Generally, immature young were kept together without regard to sex, but when mature, one male was housed with several females in the case of deermice. Voles used in the study often did not get along well together and when cage-mates were introduced, they were observed carefully to protect the weaker members. Often one vole can inflict serious injury on another very quickly. Thus, vole numbers in any one cage were kept to a minimum. The Animal Welfare Institute (1968) suggests that for laboratory mice, four mice or a breeding pair should have a cage floor space 6 x 12 inches and 6 inch deep sides. This seems to be reasonable for the wild rodents under consideration as well.

This writer feels that cages which provide for litter are superior in that the smell is minimal or non-existent which is essential when animals are kept within the classroom. Also, it appears to increase the comfort of the animals (Mr. Jim Thompson, personal communication). Several inches of shavings (commercially available or from lumber mills) seem to work well. Cedar chips, though somewhat more expensive, have a pleasant odor.

The Animal Welfare Institute (1968) suggests that bedding should be free from: dust which contributes to respiratory diseases and their transmission; splinters; vermin or diseases, and moisture. Thus commercially produced bedding is probably preferable.

One of the most important aspects of maintenance is the rigid upkeep of sanitary conditions. The Animal Welfare Institute (1968) and the Educational Department of Ralston Purina Company (1963) suggest that cages be cleaned frequently and thoroughly with hot water and detergent plus a sanitizing agent such as bleach. Afterward the cages should be rinsed with plenty of hot water. The writer found that it was not possible to autoclave or boil the cages, which is a suggested procedure (Animal Welfare Institute, 1968; Educational Department of Ralston Purina Co., 1963). Probably because a large number of animals were not housed, it was found that no diseases developed in the colonies during the study.

However, if diseases should occur, it would be wise to boil the cages and equipment in a large tub of water for twenty minutes or more, after having soaked them in a chemical disinfectant (Animal Welfare Institute, 1968).

The animals were removed to a clean cage or other container during the cleaning. In the study, soiled litter and dirtied food were placed in plastic bags and subsequently incinerated. This prevents odors and the possible proliferation of diseases and establishment of vermin. A regular cleaning regime was established, under the direction of an interested student with her own helpers. It was found that each year one student took over the responsibility of caring for the animals under the tutelage of the writer. This student seemed inevitably to be well supplied with fellow workers whom he or she directed. It would appear, from this writer's experience, that under careful initial guidance and subsequent teacher supervision, a student helper such as described above could very competently take charge of animal care.

Occasionally ectoparasites such as mites and fleas were found to inhabit the rodents. Commercial flea powder was found effective. Mr. Jim Thompson of Laboratory Animal Services at the University of Alberta suggested (personal communication) that a small piece of Vapona No-Pest Strip placed on the top of the cage for

one week, then removed for one week, followed by another week of application and so on, successfully reduces these ectoparasites without harming the animals.

In this study, the rodents were provided either with wooden nest boxes or small paper containers. The animals were provided with nesting material of Terylene, cotton wool or tissue paper which the mice soon incorporated into a nest.

Fresh water in clean water bottles with metal sipper tubes were provided ad libitum for the animals at all times. Water bottles can be fashioned out of clear bottles from other sources with a sipper tube made of glass tubing that could be fired and bent, and pushed through a rubber stopper. Colored glass is not recommended as it prevents the animal caretaker from observing the condition of the water (Mr. Jim Thompson, personal communication). The tubes must be low enough in the cage for the smallest animal to reach. It must be far enough away to prevent it from touching the bedding material and thus flooding the nest and depriving the animal of a water source (Animal Welfare Institute, 1968). It was found in this study that this occasionally occurred and thus the importance of frequent checking of the cages was recognized.

The temperature of the laboratory where the animals were kept during part of the study was approximately

65° F, the temperature used by Dr. Bell of the University of Calgary Laboratory Animals Services Department (personal communication). During the study, the temperature of the writer's classroom varied from 65° F to 80° F. When the temperature rose above 70° F, an old fan (provided by one of the parents) was set up above the cages to avoid a draft and to try to reduce the temperature and provide more comfortable conditions for the animals. The animals appeared healthy, behaved normally during these periods, and did not appear to be adversely affected. Humidity was not controlled.

The animals were kept in rooms with windows and thus were subject to normal daily lighting. Sunlight and artificial light that simulates it are best for laboratory animals according to the Animal Welfare Institute (1968).

Feeding

The writer found that lab chow for mice was the most convenient food, supplemented by fresh vegetables and fruit. The students always brought the latter items daily and the animals were provided with a varied diet. The animals seemed not to be averse to eating most human foods, although some were neglected. Hamster food was used occasionally and the animals of both species seemed to prefer the pellets to the seeds included (cracked

corn, wheat and oats). Dice (1934) developed a ration for Peromyscus which he found to be successful for breeding (Appendix VIII). Crandall (1964) successfully fed Peromyscus canary and sunflower seeds, whole or rolled oats, greens, fruits, raw vegetables, dry or canned dog food fortified with cod-liver oil, raw meat or fish. Deermice seemed to greatly prefer sunflower seeds, although voles ignored these. It is necessary to obtain the unsalted type to prevent an imbalance in the salt level and death.

The food was placed in a wide variety of containers, primarily small cans and plastic dishes and, occasionally, in the case of wire cages, on the floor. The latter is not desirable, as the food is often soiled, particularly by the voles. Both species are hoarders and often store food in their nest boxes. Wilted food was removed daily and replaced by fresh material. The plastic cages used had a trough in the lid where pellets were placed and the animals nibbled at the food through the wires. This prevents soiling and wasting of food. It also gives the animals some activity.

Handling

Over the study period, the writer kept the deermouse and red-backed vole under a variety of conditions. It appeared that the deermouse was more adaptable to cage

living and handling than was the vole, as was found by Bell (personal communication) of the University of Calgary Laboratory Animal Services Department. The deermouse was easily handled by school children and, after the first couple of exposures to them, the mice seemed to suffer little strain during the handling period. The children frequently carried the mice about in their sleeves in much the same way as they carried white mice. Voles seemed to be less willing to be handled and none of the students successfully made a pet of the vole. The voles showed agitation when being picked up and many times bit the handler (who was wearing thick leather gloves).

The animals were found to be most manageable if they were picked up by the tail (right hand) and the weight of the body placed quickly on the left hand (preferably gloved). The voles particularly and the deermice initially, would often turn around and bite the fingers of the hand holding the tail. The deermice, however, upon further handling, tended to desist struggling and biting and eventually many became fearless enough to sit quietly in the cupped hand of the student. The first few handlings of the deermouse led to the observation that the deermouse was a good jumper. Some mice were observed to leap into the air over the sides of a cardboard box that had sides two feet high.

It was found that until the deermouse was sufficiently familiarized with the ways of humans, that placing the cage into a box with sides about 2-1/2 feet high would help curtail the escape of mice and thus limit the number of nights that live-traps were set to entice the escapees back. It was found, on the whole, that deermice were very similar in their behavior during handling to gerbils. It is this writer's recommendation that voles be handled very little to prevent aggravation of the animal and painful bites to the would-be handler.

For purposes of transfer from one cage to another, or for holding while cages are being cleaned, or for the purposes of weighing, this writer found that plastic cottage cheese containers (with a liberal number of small holes bored in the cover) are excellent. They are economical, light, easily stored and very useful. They minimize aggravation of the mice as well.

Another method for handling the animals is the use of a cloth bag. Davis (1964) suggests muslin, though this writer has used cotton and has seen other workers use velvet. Davis recommends that it be about a foot long and about six to eight inches wide (a drawstring arrangement at the mouth is useful). This bag can be used to remove the animal from the live-trap by gently tapping on the end of the trap and encouraging the animal to enter the bag. However, some mice do not respond to

is used by many scientists and is very clearly described in the <u>Manual for Analysis of Rodent Populations</u> compiled by David E. Davis (1964). The procedure for handling the mouse for doing so is discussed in the section under that heading. When the mouse is securely held in the left hand, the right hand is used to cut off a toe at the base with a pair of scissors. The toes are numbered as in Figure 6 (after Davis, 1964); thus 160 mice could be thus numbered without repetition. The wound bleeds slightly and the writer felt that it might be best to do this operation out of the sight of the students. The wound heals quickly, with no visible evidence of great discomfort to the mouse.

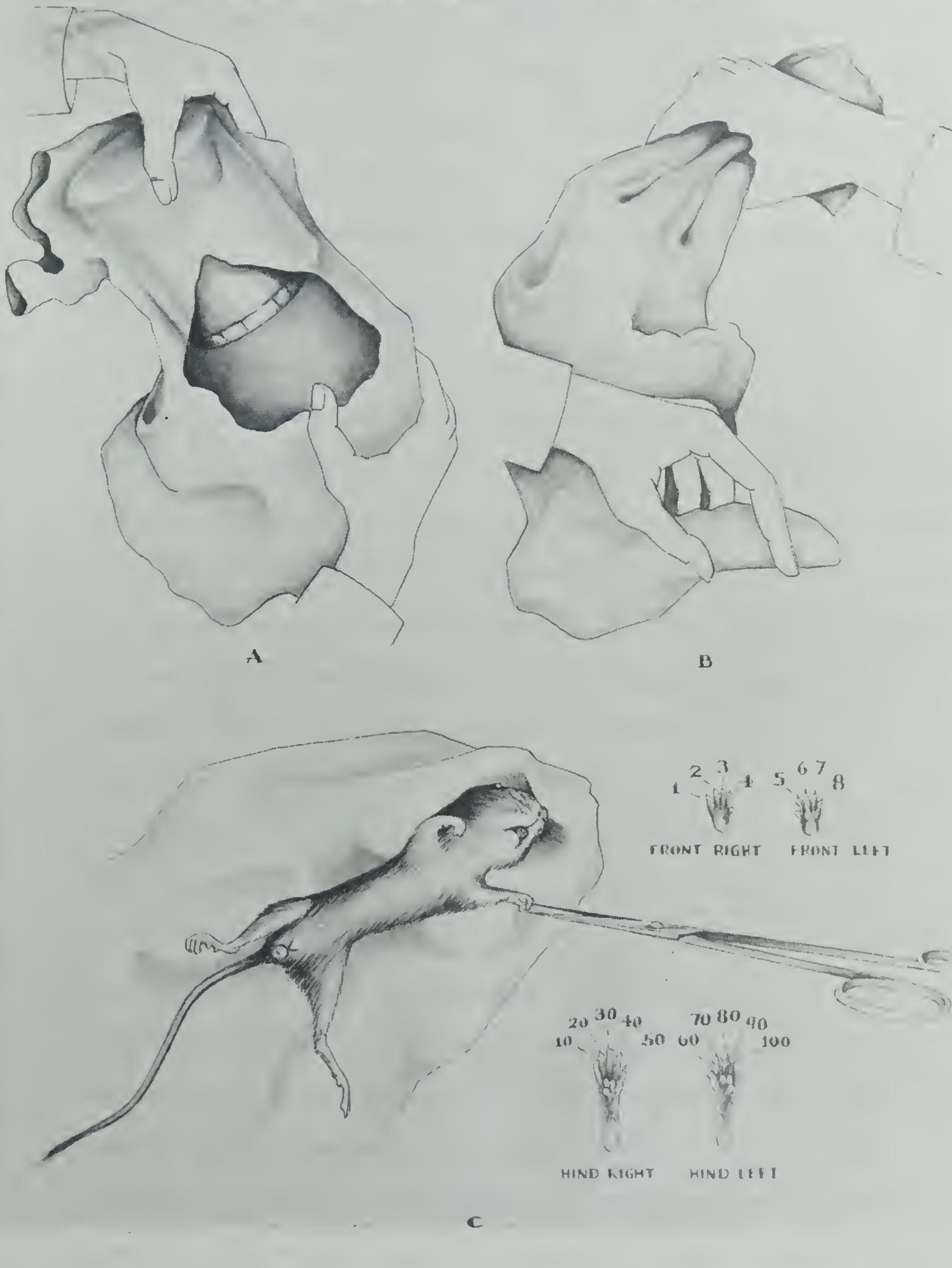
The writer found it difficult to clip toes of the young when they were newborn. Felt pen markings of various colors were often found to be rubbed or licked off by the next day. Carmon, Golley and Kennedy (1964) found that a fine hypodermic needle (attached to a syringe filled with black or white India ink) inserted in the tail or feet and a small amount of ink left under the skin was successful in producing ink spots that remained visible until the toes were sufficiently developed to be clipped.

Sex Identification

Sexing of the individuals in reproductive condition

Figure 6. Procedure for Handling and Toe-Clipping (after Davis, 1964).

REMOVAL AND MARKING TECHNIQUE



is relatively easy with a little practice. However, young or non-reproductive individuals are more difficult to sex (see Figure 7). In young, one can judge by the relative distance from anus to clitoris or penis; in females this distance is relatively longer (Benton and Werner, 1965; Melnychuk, Jacknicke and Visscher, 1970).

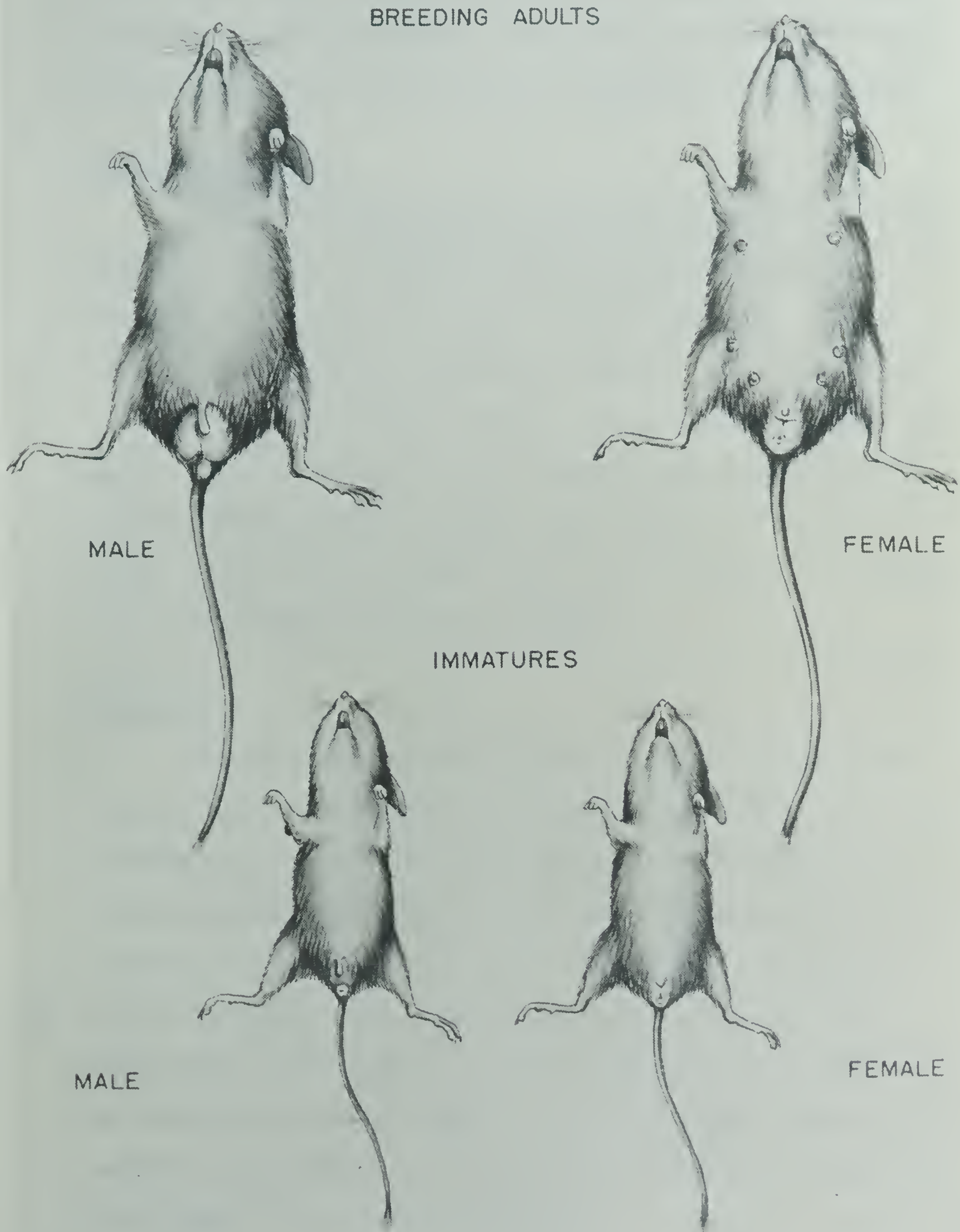
Taking Body Measurements

Measurement of the tail of the animal can be done by placing the animal in a narrow plastic box (Melnychuk, Jacknicke and Visscher, 1970) with the tail outside the box. It may take some practice to get this measurement correctly. Another method would be to hold the animal in the way described in the section on marking and then measurements of foot length could also be taken. Total body measurement presents a difficulty as the mouse generally does not stretch out at will. Thus, for live mice, tail, ear and foot measurements would probably suffice.

The live animal can be easily weighed by placing the animal in the bag described earlier, or else in a ventilated plastic cottage cheese container and substracting the weight of the container from the total weight to determine that of the mouse. Hanging pan balances present a difficulty in that oftentimes the pans on the scales are too small to hold the container.

Figure 7. Sex Identification (after Davis, 1969). Students might expect to experience more difficulty in sexing immature animals than the diagram would indicate.

SEX IDENTIFICATION



The writer has had the students use letter and parcel scales from the school office if other equipment is unavailable. Unfortunately, the metric scale is not used but the students could thus get practice in conversion.

Painless Killing

Animals which must be killed should be killed by means of cotton saturated with chloroform and placed under a perforated platform in a jar that has a tight seal (Animal Welfare Institute, 1968). This should be done outside the animal room as chloroform is deadly to mature male laboratory mice (Simmons and Brick, 1970). Carbon tetrachloride, though very effective (Lake, 1955), should not be used except out of doors as it has very toxic fumes (Mayfield, 1955).

Breeding

The writer was not able to breed voles in captivity, but did succeed in obtaining one litter of deermice in April from mice that had overwintered in the classroom. Generally a male and female were kept together in cages but these did not breed. The one litter obtained came from a colony of six mice (two males and four females). When the female was found to be pregnant, she was removed from the colony into a separate cage where she successfully raised a litter of six young, all of which survived.

Several litters of deermice were obtained from captured pregnant females, and the young were easily raised. These females were generally captured soon after the snow had melted in the spring, although one produced a litter in late August.

Dr. Graeme Bell (personal communication) has been able to breed both P. maniculatus and C. gapperi in his laboratory at the University of Calgary. The animals were housed in large plastic cages (10 x 18 x 6 inches) or larger stainless steel cages (14 x 24 x 5 inches) with one pair in the former and up to three pairs in the latter cages. Often one male is kept with two to four females. The animals were fed Purina Mouse Chow supplemented once a week with fresh carrots. Controlled lighting of sixteen hours and a temperature of approximately 65° F was provided.

The young were removed when 21 to 28 days old. Males of P. maniculatus were always left with the family, but those of C. gapperi were removed if the females seemed disturbed by their presence.

Dr. Bell observed that animals captured in the spring were more likely to breed than those caught in the fall, but some never breed in the laboratory at all. He found that those animals born in the laboratory were more likely to breed than those that were not. Also, he observed that P. maniculatus takes longer to reach

breeding condition than the voles.

Mr. Jim Thompson of Laboratory Animal Services at the University of Alberta (personal communication) has indicated that their department has had no success in breeding deermice in the laboratory, but has had success in rearing offspring of wild pregnant females. He also observed that the deermice became reproductively quiescent in the fall and remained thus until spring.

Dr. Ray Canham (personal communication) was unable to breed either species in the laboratory. On the other hand, Dice (1934) and Crandall (1969) both report that they were able to breed deermice successfully in the laboratory. Their methods of maintenance were essentially the same as those used by this writer. Hampson bred deermice successfully under lab conditions in Edmonton (personal communication).

An experiment that might be tried consists of increasing the photoperiod. Price (1966) found this to increase the number of females bearing offspring. It is the opinion of this writer that the classroom teacher should capture both animal species early in spring, thus increasing the possibilities of obtaining litters that could be observed by the students.

It should be added that in both species, the young are resilient and the family fares well with gentle handling of the young immediately after birth. The

deermouse mother never appears to become hostile when her young are disturbed, while the adult vole, which is always difficult to handle, had to be removed before her young were handled. The mother never rejected her young. It might be advised that care be taken to prevent the young from becoming chilled, and that observations be made quickly in order that the young may be returned to the nest as quickly as possible.

Recording of Data

Data collected on each animal were recorded on individual three by five inch index cards. The animals of both species were numbered serially and the numbers were never repeated. The use of these file cards was found to be exceedingly satisfactory in that information on any individual or category of individuals was readily available through a simple selection of the desired card or cards. After use, the cards were replaced in their proper numerical order.

CHAPTER VII

POSSIBLE USES OF THE RED-BACKED VOLE AND DEERMOUSE IN THE CLASSROOM

The purpose of this chapter is to provide information on the possible uses of the red-backed vole and deermouse in the classroom to illustrate some biological concepts. Some experiments were carried out in the laboratory (May, 1966 to July, 1969) and in the classroom (1967-68; 1968-69). The latter involved approximately 60 grade VIII students in the first year and 60 grade VII students and 60 grade VIII students the second year. Secondly, the writer reviewed the literature to obtain information regarding investigations on these and similar animals which might be carried out in the junior high school life science program. No attempt was made to evaluate the effect of these procedures on learning.

Taxonomy

The red-backed vole and deermouse can be used profitably in classification exercises, particularly since they represent two sub-families of the Cricetidae. Thus, they can be used to illustrate the characteristics of sub-familial taxonomic divisions.

Preparation of Study Skins

Collecting and preserving specimens was found to be appealing to many of this writer's students. Preparation of study skins allowed the students to become intimately familiar with some of the anatomical characteristics of these animals. These study skins, together with living specimens, were used in classification activities. Differences in coat color in these specimens were used to illustrate genetic variability.

Students seemed to profit by initially watching the technique demonstrated by the teacher. Subsequently, the students carried out the procedure with teacher guidance and reference to Anderson (1960), Hall (1962) and Youngpeter (1966).

The techniques used for preparing study skins were based on procedures learned by the writer from Professor C. G. Hampson in a senior biology teaching methods course at the University of Alberta. These were modified by information obtained from Hall (1962), Anderson (1960) and Youngpeter (1966), and through the writer's personal experience.

Taxidermy

The preparation of mounted specimens was thought to be too difficult and time-consuming for students. Keeler (1941), however, described a method for mounting

laboratory rats which appears feasible.

Dissection

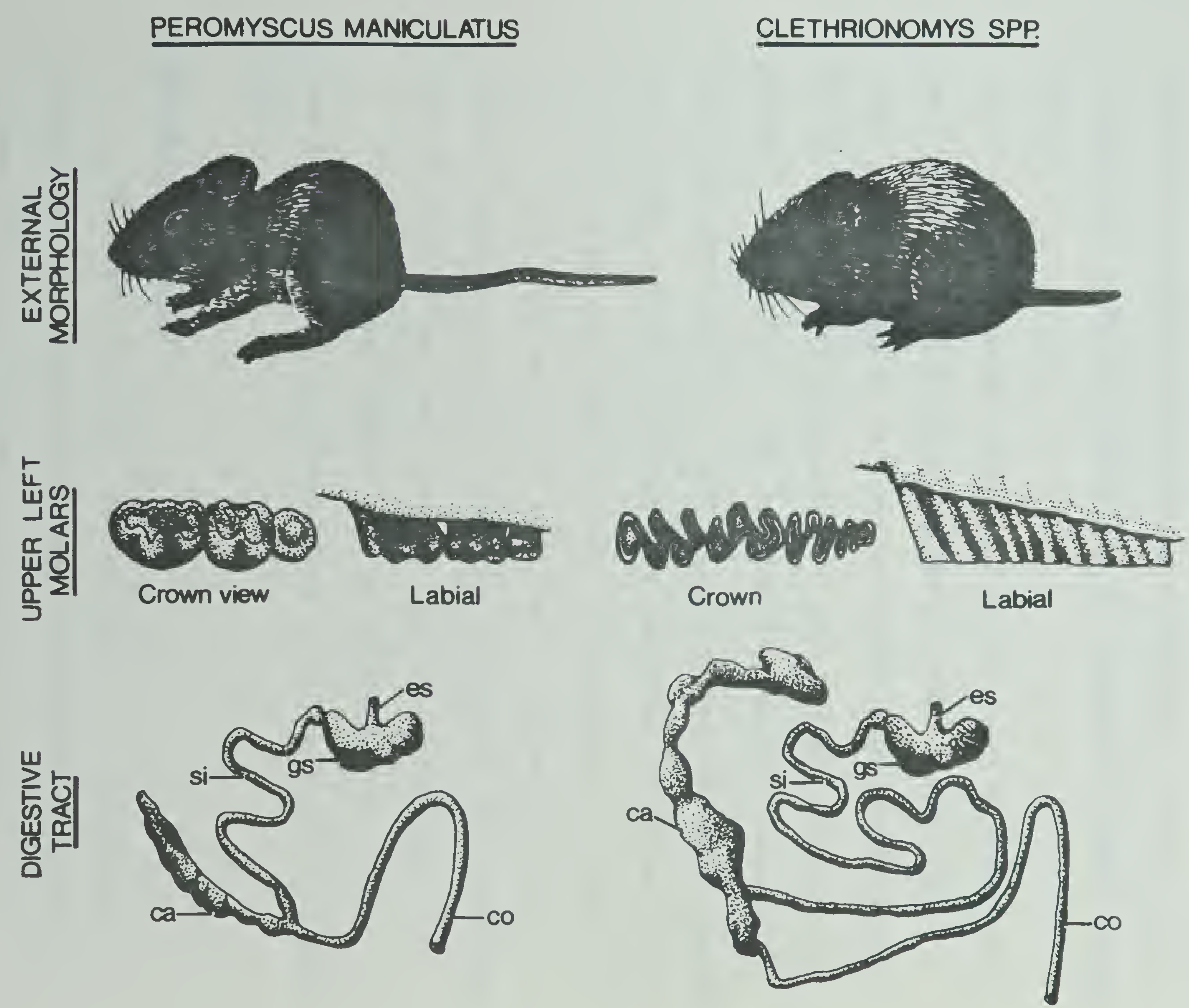
The bodies of animals from which study skins have been prepared, frozen in sealed plastic bags until required, can be used for anatomical study.

It is the writer's opinion, based on experience, that junior high school students enjoy and benefit from dissection. This view is supported by Grant (1966).

The anatomy of the deermouse and vole can be compared with that of other mammals, such as the human, and the organs can be related to their functions. For example, there are differences in their digestive tracts and dentition (Figure 8). The digestive tract, especially the caecum, of the deermouse is much shorter than that of the vole. Deermouse teeth are bunodontic and those of the vole, selenodontic. Both of these anatomical features exemplify the difference in their diets in that the deermouse is an omnivore and the vole is a vegetarian (G. R. Dyke, personal communication). This could be confirmed by a study of the stomach contents which will be discussed in a later section.

The organs of the two rodents are small but this disadvantage is counteracted by the fact that since they are easily obtained at no cost, enough animals can be provided to supply one for each student. It was found that few of the students were too timid to attempt dissection.

Figure 8. A Comparison of the External Morphology, Dentition and Digestive Tract of the Deer-mouse and Red-backed Vole. ca, caecum; co, colon; es, esophagus; gs, glandular stomach; si, small intestine. (With permission from G. R. Dyke.)


PEROMYSCUS MANICULATUS
CLETHRIONOMYS SPP.
EXTERNAL MORPHOLOGY
UPPER LEFT MOLARS
Crown view
Labial
Crown
Labial
DIGESTIVE TRACT
es
gs
si
ca
co
es
gs
si
ca
co

Preparation of Skeletons

The skeleton of the animal can be prepared and mounted as part of a student project but the work is tedious. Methods of preparing skeletons are described in Anderson (1960), Benton (1965) and Hall (1962), among many.

The skulls of the animals are easy to clean and can be used for illustrating dentition. Allen and Neill (1950) suggest the use of mealworms (tenebrionid beetle larvae) for cleaning off the tissue from small skulls. These worms are inexpensive and are available from most pet stores. They will not spread as do dermestid larvae, which are generally used for cleaning skulls. The mealworms are kept in bran with pieces of potato or apple to provide moisture and food. Allen and Neill (1950) suggest that the skull be placed in the container with the mealworms and covered lightly with bran.

The cleaned skulls can be conveniently stored in plastic vials such as those used to store pills (Palmer, 1946).

Age Determination

In order to study the ecology of a particular species, it is often necessary to determine accurately the absolute age of animals (Tupikova, Sidorova and Konovalova, 1968). Tooth length is often used to

determine age. The method requires study of a great number of animals to establish an accurate scale, and is probably not a worthwhile exercise for students.

If enough teeth are available, however, they could be used for teaching measurement and graphing skills, introducing the concept of variation, and familiarizing the students with a technique used by ecologists to study populations.

Histological Studies

Organs of the deermouse and vole can be used for histological study. The tissues should be preserved in 10% formalin neutralized by adding calcium carbonate until no more will dissolve (Davis, 1964). In general, the organs should be obtained from animals that have been just killed. Small amounts of each organ is all that is necessary. However, whole organs can be preserved but the quantity in the preservative must not exceed ten percent of the total volume, thus ensuring rapid preservation (Davis, 1964).

Slices of the tissues collected can be made with a microtome or razor blade and studied microscopically. Simple stains, such as eosin and hemotoxylin might be necessary to distinguish the nucleus and cytoplasm.

Parasites

Parasitism as a way of life is a fascinating study. The prevalence of parasitism can be easily demonstrated in the red-backed vole and deermouse, and the parasites thus obtained could be used in classification activities as well.

The technique used by the writer for collecting ectoparasites was similar to that described by Davis (1964). Some cotton moistened with chloroform or carbon tetrachloride was dropped into the paper bag containing the carcass and the bag was resealed. Another possibility suggested by Davis (1964) is to spray the contents of the bag with an aerosol insecticide bomb for not longer than three seconds.

Next, the animal was removed from the bag and the fur was brushed against the nap with dry forceps. The parasites that dropped or ran out were collected with a camel-hair brush. Alternately, forceps dipped in alcohol will also work (Davis, 1964). The inside of the bag was also examined. In this fashion, the writer found fleas on almost all specimens examined.

The parasites were then preserved in a vial containing 70 per cent alcohol and labelled with the number of the host. Formalin should not be used as a preservative (Davis, 1964).

Ectoparasites could also be collected with a

tongue depressor covered with cellophane tape, sticky side out, pressed onto the desired area of the animal. The tape is then removed and placed sticky side down on a slide, thereby permitting microscopic examination (Stone and Manwell, 1965).

To study internal parasites of albino laboratory mice, Stone and Manwell (1965) suggested that the intestine be removed in one piece, from the cardiac sphincter to the anus. Scrapings and fecal material taken from different areas are placed on slides along with 0.9 percent NaCl and covered with a cover glass. When taken from freshly killed animals, the parasites apparently remain viable for some time in the NaCl solution. Iodine can be used to stain cysts, but it will kill the parasites. Next, the intestine is placed in a petri dish filled with eight milliliters of 0.9 percent NaCl and stirred to release the parasites. Worms can be seen and counted under a dissecting microscope. Samples of the material viewed under a compound microscope frequently reveals protozoa and worm ova. The above techniques could be easily adapted for use with the animals of this study.

Murray (1961) studied parasites of _C. gapperi_ and _P. maniculatus_ in Alberta. It would appear from his results that cestodes and nematodes were found in abundance. G. R. Dyke (personal communication) occasionally

discovered nematodes in the stomachs of voles but never in those of deermice.

Hair as a Diagnostic Character

Hair or fur is often used as a diagnostic clue to species identification by ecologists. Fecal and regurgitated matter and stomach contents of predators are examined for hair which is identified by comparison with a reference collection. Students could easily prepare permanent mounts of deermouse and vole hair and use it to identify contents of owl pellets and hawk feces.

Moulting Patterns

Students could observe moult patterns in mice and voles to determine if they are similar to those of other mammals. Hafez and Dyer (1969) reported that in most mammals the fall moult begins on the abdomen, proceeds from the rump toward the head, and at the same time spreads progressively over the lateral surfaces to the back. The spring pattern is the reverse of the fall moult in that it begins on the head and back regions and proceeds ventrally and posteriorly.

The hair growth cycle is governed directly by heredity, hormones, and the photoperiod, and only indirectly by temperature (Hafez and Dyer, 1969). Thus students could subject the two rodent species to different light regimes to determine their effect on moulting.

Gottschang (1956) found that the moult pattern in *P. leucopus noveboracensis* juveniles is different from that of the adults. Students could determine whether or not these age differences in moulting pattern exist in the deermouse and red-backed vole.

Activity Patterns

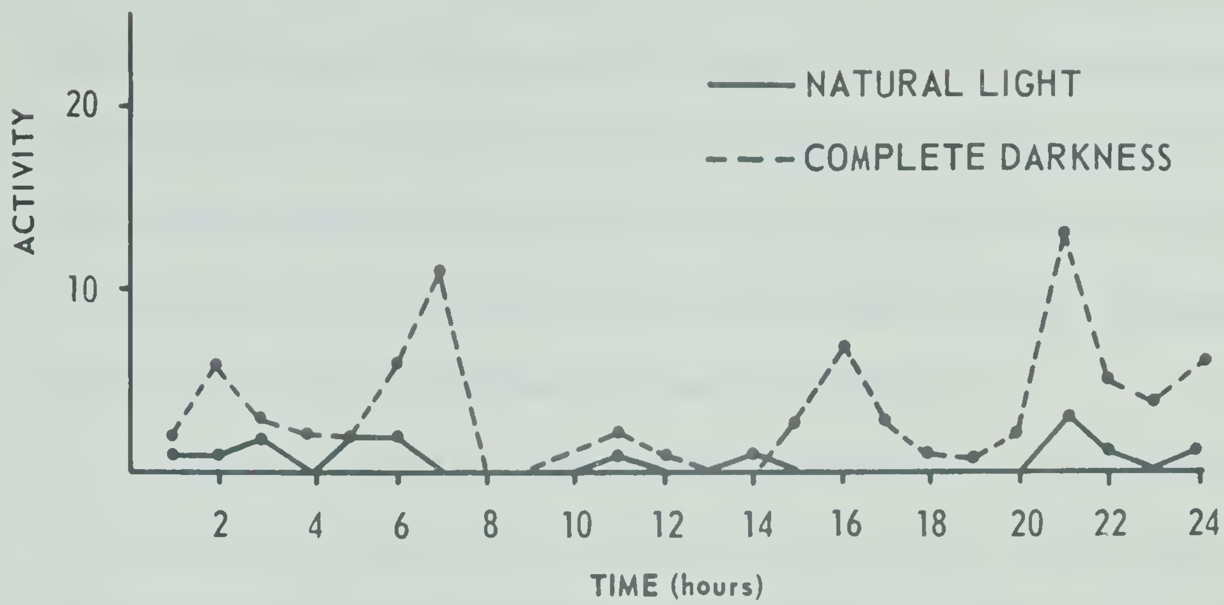
According to Getz (1968*b*), time and intensity of activity are important in determining the microclimate in which an animal lives, as well as indicating the duration an individual is exposed to given environmental conditions.

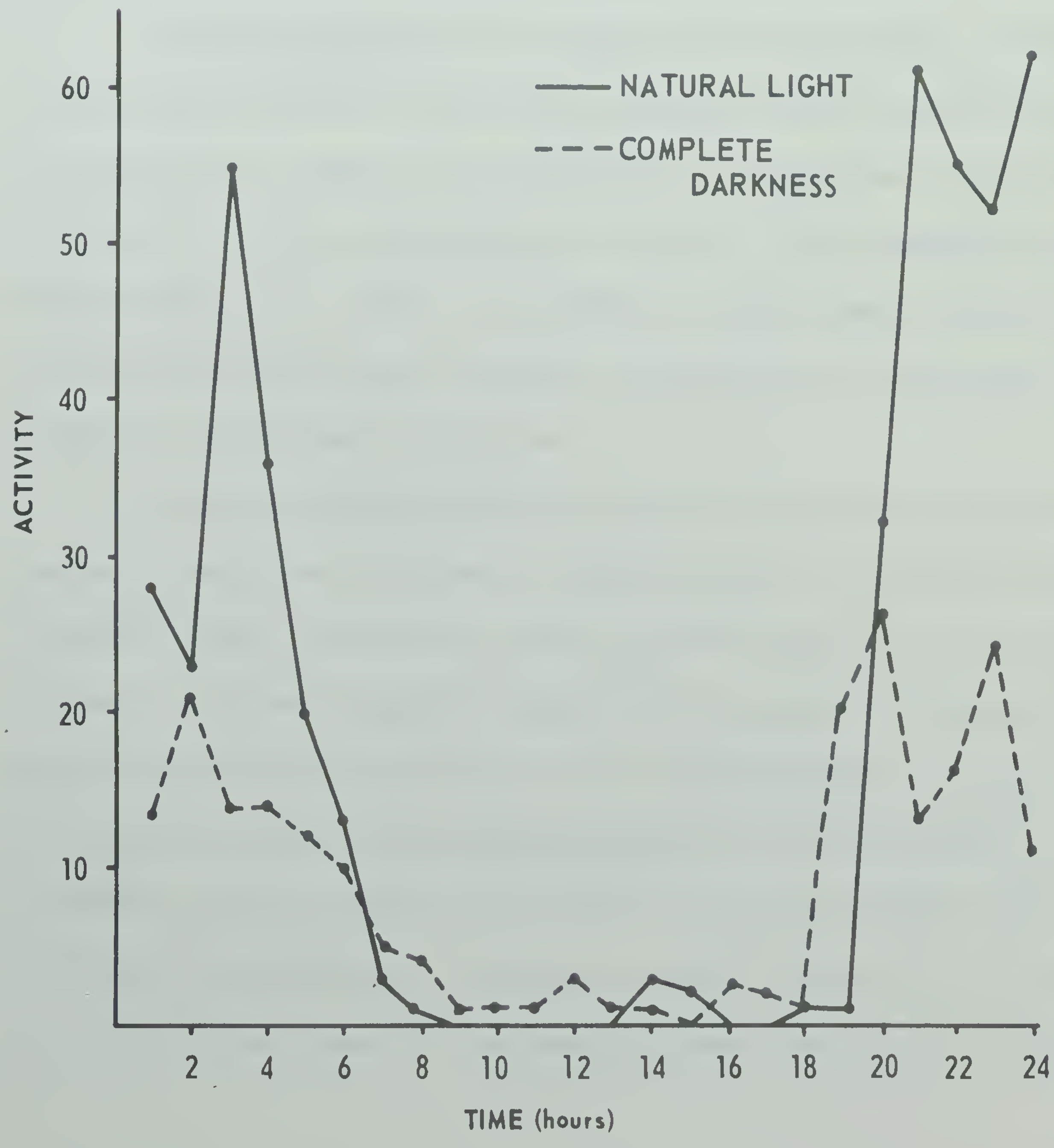
In the literature there are conflicting reports on *C. gapperi* activity patterns. It has been described as being seen abroad in daylight (Hamilton, 1943), active day or night (Burt and Grossenheider, 1964; Buckner, 1964), chiefly nocturnal but often active during the day (Jackson, 1961), and definitely nocturnal (Shaw, 1924). Getz (1968*a*), after intensive research into the problem, indicated that wild-captured voles generally had seven periods of activity, separated by intervals of inactivity, occurring over a 24 hour period. He found *C. gapperi* to be two or three times more active at night than during the day. These results are similar to those of Stebbins (1968) and of the writer (Figure 10).

Under conditions of complete darkness, the writer

Figure 9. Daily Activity Pattern of _C. Gapperi_ from Ellerslie as Tested at Edmonton. One male was tested first under conditions of natural light during the period of March 25-30, 1966, then under conditions of complete darkness during the period of March 31-April 2, 1966. The term 'activity' refers to the average amount of time spent by the animal in an activity wheel as expressed by the density of signals in millimeters as recorded on the moving graph paper of an event recorder. Time is given with hour 0100 through hour 2400 abbreviated to hour 1 through 24.

Figure 10. Daily Activity Pattern of _P. Maniculatus_ from Edmonton as Tested at Edmonton. One female was tested first under conditions of natural light from March 25-30, 1966, then under conditions of complete darkness from March 31-April 5, 1966. For details refer to the legend for Figure 9.


NATURAL LIGHT
COMPLETE DARKNESS
ACTIVITY
20
10
2
4
6
8
10
12
14
16
18
20
22
24
TIME (hours)


NATURAL LIGHT
COMPLETE DARKNESS
ACTIVITY
60
50
40
30
20
10
2
4
6
8
10
12
14
16
18
20
22
24
TIME (hours)

found that the activity followed a pattern similar to that established in natural light, with a slight shift in occurrence of peak periods. Getz (1968*a*) failed to obtain any shift, but Stebbins (1968) did. The intensity of activity was found to increase under total darkness which was also observed by Getz (1968*a*).

Getz (1968*c*) found that the activity pattern of the vole was regulated primarily by light, and that differences in temperature and humidity conditions, at most, only modified the amount of activity.

P. maniculatus was found to be primarily nocturnal with some activity occurring between 1300 and 1600 hours (Figure 10). This is similar to information obtained by Hatfield (1940) and Stebbins (1968). The constant darkness produced a shift in activity, plus small peaks of activity during the original daylight; the pattern, however, remained unchanged.

A study of activity patterns could be carried out using a modified recorder (Appendix IX), developed by Triner (1965), that was found by the writer to be adequate. An even simpler method that might be used is one described by Meltzer and Folk (1958) wherein bladder emptying is used as an indication of total activity in rodents. The animal was housed in a galvanized can which is placed between two pieces of mesh serving as top and bottom of the cage. A graduated tube was then attached

to the cage to measure water consumption. Food pellets were placed in the cage. Upon urination, the urine flowed via a plastic funnel attached to the base of the floor and over a glass bulb which pinpointed the sample on the sloped rim of a revolving paper plate. The paper plate was rotated once in 24 hours by means of a clock. The time of urination was ascertained by superimposing a transparent clock face. (The paper plate could be replaced every 12 hours and an ordinary clock used.) The activity could then be graphed much as in Figures 9 and 10. Various light regimes, such as continuous darkness, continuous light, or light reversal could be used to see if activity rhythms are alterable or inherent. The effect of cold on activity could be studied, which Hatfield (1940) found to cause a decrease in activity and increase in food consumption, but not significantly.

Morhardt and Hudson (1966) found they could induce torpor in Peromyscus species by reducing rations for short periods in laboratory fattened animals. The authors suggested that torpor makes survival possible when the animals are confronted with limited energy resources--be it the result of low temperatures, lack of food or moisture. They found these torpor periods to coincide initially with the incidence of the light period.

Need for Cover

According to the data collected by the writer (see Chapter VI which discusses trapping results) as well as reports from the literature, deermice require less cover than do voles. These observations were made indirectly by interpretation of habitat differences in trapping results. A simple study could be done under "black lights" using animals marked with phosphorescent paint or else faint ordinary light could be used. The animal could be placed in a cage divided into two parts, one with no cover and the other with various types of plants in simulated cover. Both parts could be provided with food and water. Experimental animals could be loosed and the amount of time spent in the compartments recorded for both species and then compared. The effect of variations in the type and density of cover could be studied. A study similar in design was carried out by Klopfer (1967) to study foliage requirements of birds.

Learning Processes

According to Proctor (1940), the study of learning behavior in white rats was a profitable learning experience for his high school students who constructed a Hampton Court Maze as is used in many psychology experiments.

Food was denied the animals on the day they were

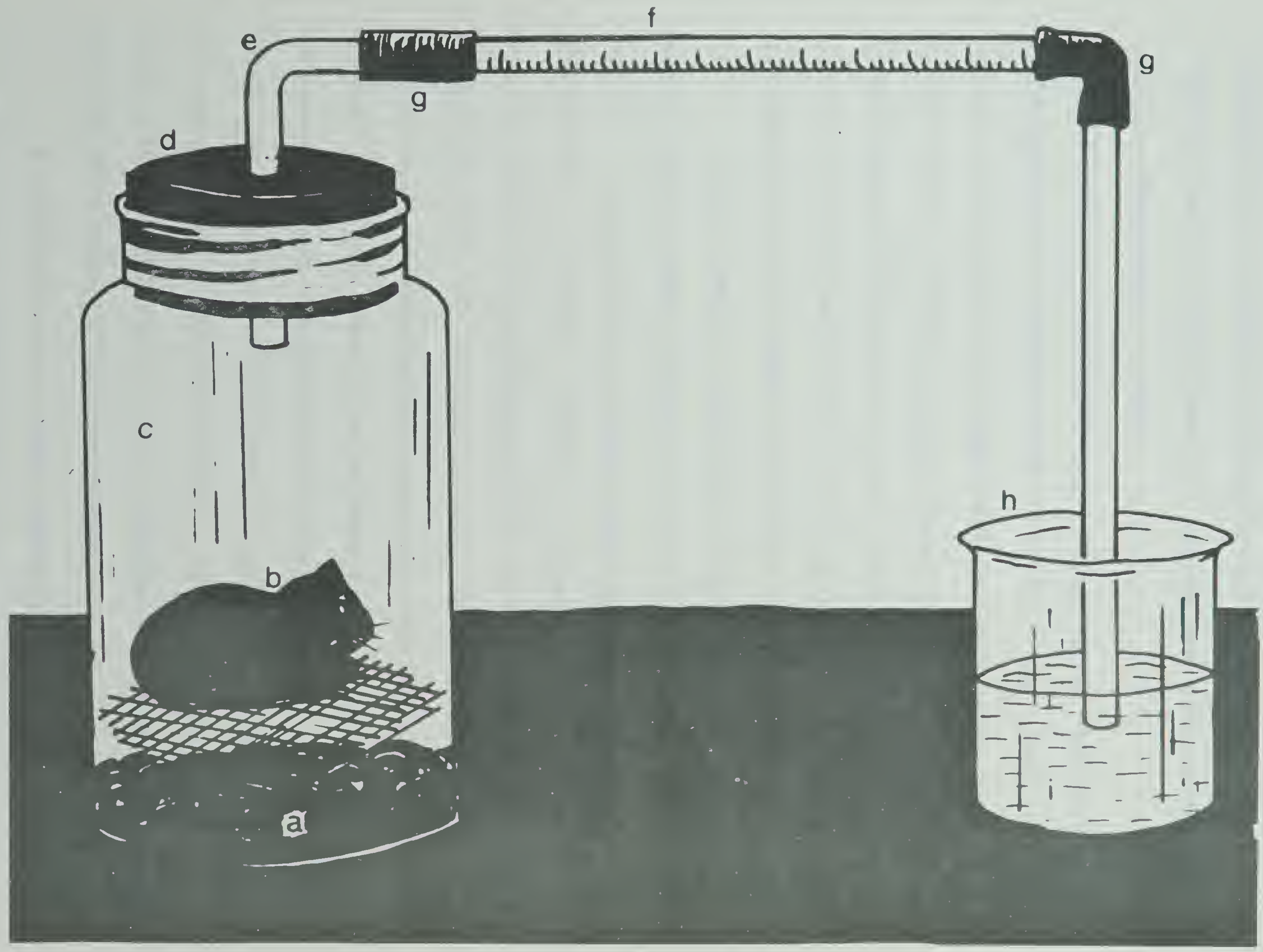
to perform; on other days they were fed at three o'clock p.m. Age and hereditary differences were controlled by using animals from one litter. The students compared the results of the males and the females. The data recorded consisted of: time taken to solve the maze; blind alleys investigated; blind alleys entered; and time used in eating at the end of the maze. Topics which were discussed by Proctor's classes as a result of the study included statistical significance of differences, forgetting rates, and the relation of learning in rats to that of humans.

The writer's students designed several mazes of their own. It was found to be a popular experiment, but it required careful guidance on the part of the teacher to relate the experiment to learning theories.

Energy Requirements

The energy requirements of an organism are determined by many factors, some of which can be readily investigated by students in junior high school. Oxygen consumption is generally accepted as a reliable direct measure of the metabolic rate of any animal (Pearson, 1947; Hoar, 1966). A simple respirometer (Figure 11) could easily be constructed by students. The results can be translated into calories expended, by assuming that one cubic centimeter of oxygen consumed is the

Figure 11. A Simple Respirometer. As the air is used by the animal in the chamber (c), the water level in the burette (f) changes. Actual consumption of air can then be calculated. The carbon dioxide is absorbed by the soda lime (a) and the moisture by the calcium chloride (a). b, animal; c, mason jar; d, cork (sealed edges); e, bent glass tubing; f, graduated burette; g, rubber tubing; h, beaker; i, water.
The burette might better be placed vertically.



a
b
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e
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equivalent of 0.004825 calories (Bingham, 1939). Food consumption is another parameter which can be used to compare energy requirements in organisms of the same species (Sealander, 1952).

Energy requirements are affected by the physical relationship of surface area to mass. Meglitsch and Wessel (1949) point out that smaller organisms have a higher heat loss than larger ones, thus the energy requirements are greater in the former, resulting in increase in the heart rate, body temperature, speed of reproductive cycle and respiration rate.

Under similar conditions then, smaller animals, would require more oxygen and food (of similar nutritive value), per gram body weight, than would larger ones. Respiratory exchange, however, depends on the type of fuel and what is happening to it in the organism. Valid comparisons of the metabolic rate of animals, then, should only be made under carefully controlled conditions, minimizing muscular movements as well as the effects of food ingestion and related metabolic activities, by comparing metabolism of animals during periods of fasting and inactivity (Hoar, 1966). Thus, intraspecific comparisons of food consumption might not reveal the surface area to mass relations.

A study by G. R. Dyke (personal communication) revealed that <u>P. maniculatus</u>, the smaller animal, ate

significantly less lab chow than *C. gapperi*, both in terms of total volume and per gram body weight. The same study found indications that the volume of natural foods consumed in the wild was similar. The diets of the two species, however, differ in energy value, thus volume has little meaning as an index of comparison. The laboratory results might indicate differing ability on the part of the two species to utilize food (i.e. lab chow) (Hoar, 1969).

Various factors such as ambient temperature and previous thermal experience affect the respiration rate and consequently the volume of food consumed (Howard, 1951; Hafez and Dyer, 1969). Sealander (1952) found that food consumption in *P. maniculatus* varied inversely as the temperature. Animals with a warm thermal history had higher rates of food consumption after fifteen days at intermediate or low temperatures than did animals with a cool thermal history. Sealander (1952) postulated that the animals with a warm thermal history had thinner pelages and thus compensated for a reduced insulative efficiency at low temperatures by increasing the rate of heat production through increased food consumption.

Peromyscus are able to compensate for limited energy resources, as was previously stated. Students could measure the respiration rate of deermice during periods of torpidity and discuss its survival value.

Other factors, such as sex differences, also transcend the generally direct surface area to mass relationship (Hoar, 1966). G. R. Dyke (personal communication) discovered that when food consumption of the two sexes was compared, males ate more (though not significantly more) than females of the two species. Prosser and Brown (1962) stated that females generally tend to have a lower metabolic rate than males of the same size. This difference, they postulated, may be due to the greater proportion of tissues of lower metabolic rate (such as fat) in the female. G. R. Dyke (personal communication) found, however, that in the wild the females of both species ate more food than males during the spring and summer, particularly in May. This phenomenon can probably be explained by the pre- and post-parturition energy requirement of the female at this time.

Animals generally do not experience the thermal environment one would expect from physical measurements of the environment. A behavioral thermoregulatory practice of young birds and small mammals is huddling (Hafez and Dyer, 1969). Oxygen consumption of young pigs is reduced at temperatures below the thermoneutral zone by the practice of huddling (Hafez and Dyer, 1969). The students could compare oxygen consumption of young mice and voles when huddling and when apart at a particular ambient temperature.

Temperature Selection

Many homeotherms avoid extreme temperatures by seeking or constructing more favorable microclimates. The red-backed vole and deermice survive in areas where air temperatures reach -40° C, by seeking a more suitable microclimate under the snow (Fuller, Stebbins and Dyke, 1969).

Temperature selection in Peromyscus was carried out in the laboratory by Ogilvie and Stinson (1966), using a copper rod temperature gradient in a box. Observations were made to determine the preferred temperature. Students could carry out a similar experiment to determine temperature preferences of the two rodent species, and try to relate these to the natural microclimate of the species.

Food Habits

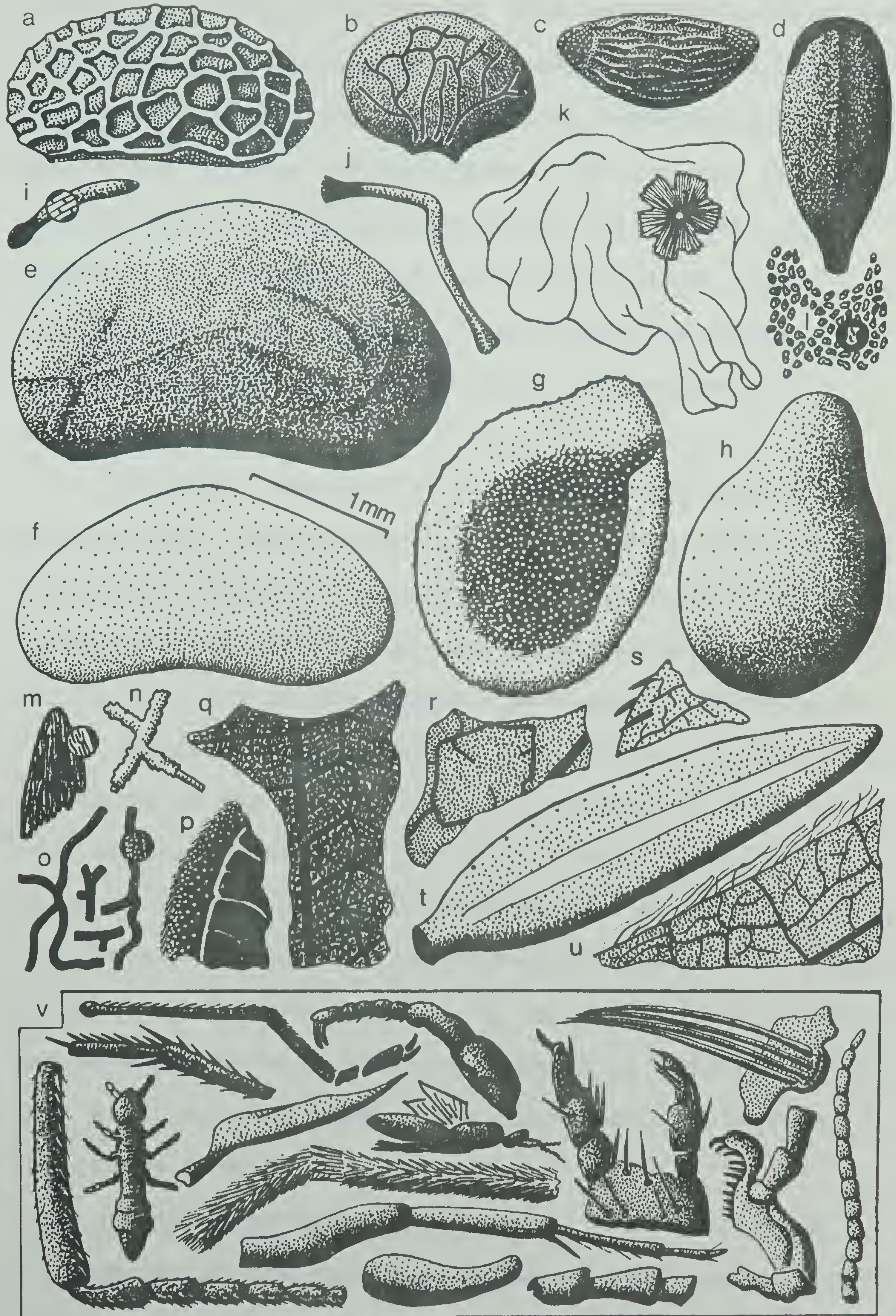
Dexter (1951) suggested that one aspect of ecology that could be investigated by students is the study of food habits through stomach analysis. The stomach is removed by cutting the esophagus and duodenum near the pyloric valve (Benton and Werner, 1965). The stomach can then be preserved in vials containing four percent formalin (Mosby, 1953). Williams (1959) found that fresh material was more easily identified. Either preserved or fresh stomach contents should then be washed in moderately

hot water to remove fat and gastric juice or formaldehyde (Williams, 1959). For the next step, it was simplest to strain the contents through nylon stocking material tightly stretched over a petri dish and transferred to water in a clean petri dish. Several changes of water may be desirable to clean the contents sufficiently to allow the recognition of such parts as may be determined (Hamilton, 1941). The contents are then viewed under a dissecting microscope. Identification of material might present a problem unless a reference collection of plant parts, particularly seeds, is made from the vegetation on the trapping site (Williams, 1962). G. R. Dyke (unpublished doctoral thesis) kindly permitted the use of drawings he made of some common foods found in the stomachs of boreal deermice and voles in the Northwest Territories (Figure 12). Most of these foods would probably be found in the stomachs of Alberta animals.

Hamilton (1941) found that stomach contents of *P. maniculatus* were generally more easily identified than those of *C. gapperi* because, in the latter, the food was more masticated.

The contents should be identified and the approximate percent composition determined (by means of a grid, such as graph paper, under the petri dish). If a number of stomachs are analyzed, the percent frequency of occurrence should be calculated. That is, the number of

Figure 12. Some Common Substances Found in the Stomach of P. maniculatus and C. gapperi. All are drawn to the same scale. a-h, seeds; a, Rubus strigosus; b, Fragaria virginiana; c, Vaccinium vitis-idaea; d, Rubus oxyacanthoides; e, R. chamaemorus; f, R. acaulis; g, Arctostaphylos rubra; h, Cornus canadensis; i, persistent style of F. virginiana; j, persistent style of R. strigosus; k, ectocarp of Shepherdia canadensis; l, "flesh" of Arctostaphylos uva-ursi fruit; m, "leaf" of Hylocomium splendens; n, Usnea sp.; o, Alectoria jubata; p - u, leaves; p, A. uva-ursi; q, Populus tremuloides; r, Geocaulon lividum; s, Linnaea borealis; t, Empetrum nigrum; u, F. virginiana; v, arthropod parts (with permission of G. R. Dyke).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stomachs in which a particular item appeared is obtained, then divided by the number of stomachs examined (Benton and Werner, 1965). Next the percent volume should be determined for the various items. The percent volumes of the items in all the stomachs is calculated, then divided by the number of stomachs multiplied by 100 (Benton and Werner, 1965). Comparisons could then be made between the species, according to season if possible.

From the analysis of the stomach contents of C. gapperi and P. maniculatus of the Northwest Territories, G. R. Dyke (personal communication) concluded that the former is a vegetarian and the latter an omnivore, eating insects during the summer, particularly (Figure 12).

Whitaker (1966) discovered that in farming regions, one-third of the food by volume consisted of cultivated crop seeds, one-third of which was soybeans and wheat. About 15 percent of the food consisted of wild seeds, and an equivalent amount of lepidopterous larvae. If students in Alberta analyzed contents of the stomachs of deermice and obtained results similar to those of Whitaker (1966), they might discuss whether the deermouse is, in fact, a foe of the farmer.

Another method of determining food habits and preferences of the vole and deermouse would be to offer various types of food to the animals, cafeteria-style.

The weight of each food eaten, plus observations on the parts preferred could be observed. Menhusen (1963) offered various combinations of three to nine plant species per day, in addition to a constant supply of a dried ground mixture of corn, wheat, oats and milo. G. R. Dyke (personal communication) followed a method in which one food was offered at a time, in addition to lab chow, and the quantity of the experimental food was compared to that of lab chow to get a ratio for comparison purposes.

As was previously mentioned, the gut tract of the deermouse is shorter than that of the vole, and the teeth differ (Figure 8). The students, in studying food habits of these animals, could discuss the significance of these morphological differences.

Handling of Food

Closely associated with the food habits is the way in which the red-backed vole and deermouse handle their food. Students might compare how the animals hold their food when they eat; how they carry it from place to place; and, if they store it, the location, quantity, and method of storage.

Sense of Smell in Seed Detection

Howard and Cole (1967) investigated olfaction in seed detection by deermice. The animals were placed in

a large pen (10 X 20 feet) with a floor covered with a layer of peat. A petri dish with one seed was hidden. Each experiment was run for one night. Depth made no difference. Howard and Cole (1967) found that olfactory stimuli in seeds either attracted rodents sufficiently to investigate or prove so unattractive that further exploration was discontinued. The evidence seemed to suggest that odor is important in palatability of seeds. A seed "treasure hunt" for mice and voles could be an interesting project for students.

Color Vision

Many mammals are color blind and do not react to many of the colors that humans do. Students could investigate perception of color of food in the deermouse and vole by offering them food pellets dyed with food dyes to see if there are any differences in preference.

Perception of Taste

There are four recognized classes of taste for humans (sweet, salt, bitter and sour). Perception of what is palatable in other animals is often fallaciously assumed to be that which appeals to humans (Hafez and Dyer, 1969).

Generally two-bottle, 48-hour drinking preference tests are used to determine species differences in taste sensibilities. They are typically interpreted in terms

of acceptance, indifference and rejection of test solutions. Harriman (1968) is of the opinion that these categories may obscure possible equivalence among species with respect to orders of acceptance for items in a set of taste stimuli. Thus the orders of acceptance for chlorides in his study were based on intakes of milliliters/ 100 gram body weight/ day. Chlorides used, which have no detrimental effect in small concentrations, were NaCl, KCl, NH_4Cl, $CaCl_2$, $MgCl_2$ and $SrCl_3$ at 0.10 M and 0.14 M concentrations. The results showed that there was a similarity in the preference for chlorides in certain birds and mammals.

A two-bottle preference test can also be used to determine acceptance of sugars. Clark and Harriman (1969) found that fructose, glucose, lactose, maltose and sucrose were preferred over water at low concentrations by squirrel monkeys (*Saimiri sciureus*). At intermediate concentrations there existed a significant preference for fructose, glucose and lactose only. At high concentrations, there were decrements in preference for fructose, glucose and sucrose; the other two were rejected entirely. These results point out that the common sugars are preferred by these animals, as they are in many other species (Clark and Harriman, 1969).

Sense of Touch

The vibrissae have long been accepted as important tactile organs in mammals. Pearson (1962) found that by clipping one side, both sides and no vibrissae on *Microtus californicus* and *Reithrodontomys megalotis*, no visible effects were produced on behavior. Students could possibly carry out such an experiment on *Peromyscus* and *Clethrionomys* to try to discover some survival value of the vibrissae.

Water Consumption

Water consumption studies in the laboratory have revealed that water balance, as influenced by microclimate, affects the distribution of *C. gapperi* and *P. maniculatus* (Getz, 1968*b*). This writer found in a comparison of water consumption in the deermouse and the red-backed vole, that the former drinks significantly less water both in total volume and per gram of body weight (Table XVII). Note that statistical significance is attained from very few individuals, making this experiment suitable for the classroom where numbers of animals would be restricted. The data is supported by Getz (1968*b*) and Odum (1944), who feel that the distribution of *C. gapperi* is restricted to low, wet areas by its water needs. Hampson was able to maintain *P. maniculatus* on a regimen of commercial bird seed alone for almost indefinite

TABLE XVII

COMPARISON OF RATES OF WATER CONSUMPTION IN THE DEERMOUSE AND THE RED-BACKED VOLE.

Values are from 10 animals of each species.

Species	cc/Water/Day	cc Water/Day /g. Body Wt.
P. maniculatus	5.15* ± 0.70**	0.25 ± 0.045
C. gapperi	12.43 ± 1.88	0.53 ± 0.066
P value	$0.001 < p < 0.005$	$0.005 < p < 0.01$

* mean

** standard error of the mean

periods. The animals did not suffer visibly from the absence of water. This experiment could be duplicated by students. It might lead to a study of adaptations of these and other organisms to dry conditions.

Getz (1967) found that *C. gapperi* is a better swimmer and more inclined to do so than *P. leucopus*. These behavioral responses seem to reinforce the physiological requirements.

Burrowing Behavior

Microclimate selection by organisms, discussed previously, is an important behavioral characteristic. The deermouse and red-backed vole spend much of their time in run-ways and subterranean cavities. This writer was not able to find any studies done in North America concerning the origin of these runways and cavities. Thus, a project was undertaken by some of the writer's students to determine if *Peromyscus* and *Clethrionomys* will undertake the digging of tunnels in the soil. The animals were kept in a 20-gallon aquarium, covered with black paper, three-quarters full of clay soil. A layer of leaf litter two inches deep covered the soil. It was found that both species dug cavities into the soil. Tunnels, which collapsed immediately, were built by both species. It seemed that the soil was too loose to be suitable for tunnels. This study was not satisfactorily

completed because it had to be terminated before completion. However, the author feels that this topic has a great deal of potential in revealing behavior of these animals in a simulated natural environment.

Arboreal Behavior

The body form of the deermouse differs considerably from that of the red-backed vole (Figure 8). It would appear that these differences must have behavioral implications in terms of climbing ability, and thus the stratum of activity of the species. Getz and Ginsberg (1968) studied the ability of *P. maniculatus* and *C. gapperi* to cross horizontal stems. Neither species was found to display arboreal behavior, and both had difficulty in crossing the horizontal stems. Both species seemed to walk similarly, placing almost the entire foot on the stick, with their bellies close to the stick. The deermouse, unlike the vole, used its tail in balancing by swinging it from side to side or around the stick. According to Getz and Ginsberg (1968), the deermouse and vole both differ from *P. leucopus* (an arboreal species) in the way they place their feet. Tails, length of toes and toe nails, were found to be unimportant in climbing ability.

Students could carry out a variety of experiments to determine differences in climbing ability in the two

species. Nest boxes could be placed at various heights in a roomy cage with sticks leading to them. Observations could be made to determine which nest boxes are preferred. Also, it would be interesting to determine in which of these compartments the animals would choose to store their food.

Locomotion

The study of locomotor behavior is a complex science. Students could, however, compare foot placement patterns in the two species by having the animals run across smoked paper, or by observing patterns in snow. Similarly, by dusting a board lightly with flour, pupils could study footfall patterns of the two species. The tail print of the deermouse is the most significant difference. From this, it would seem that the tail in this species is used in balancing.

A comparison of how the two species use their feet (toes, palm, heel) could be made. As well strides could be measured, recorded and compared.

Observation and photography could be used to determine the types of locomotor patterns used by the animals.

The speeds of the two rodents could be determined by timing with a stop-watch over measured distances. Layne and Benton (1954) found that *P. m. bairdii* attained

an average speed of 8.0 feet per second and C. g. gapperi, an average of 6.1 feet per second. The values obtained could be related to morphology, locomotor pattern used, and adaptive significance.

Signs

Although the suggestion for use of the red-backed vole and deermice have been generally limited to those in the classroom, the animals must be collected outdoors.

When the traps are set out, it might be interesting to set out some scat boards. Benton and Werner (1965) suggested that 4 x 4 inch plywood or masonite boards be distributed with the traps. The frequency of occurrence of scats will give an indication of population size. The scats collected can be compared with a reference collection for identification.

Perhaps a more interesting activity would be to spread a good slippery, sticky, clay mud evenly on pieces of polyethylene late in the evening. The area can be baited with a piece of food in the middle. To preserve the tracks for more detailed study and identification, the tracks can be poured with plaster the next day (Phillips, 1964). Identification could be carried out by reference to prints made by known animals in the classroom, as well as to Soper (1968).

Behavior Patterns

There are many behavioral studies that might be carried out in the classroom. Recording of data is often difficult in these studies, so students should be carefully guided (see Stokes, 1968). Studies should be of short duration so that students are not bored by collection of vast quantities of data. Various experiments that are adptable for use with the red-backed vole and deermouse by junior high school students are available at a cost of 25¢ each (Stokes, 1968). The topics with possible potential include studies of wall-seeking behavior, negative geotaxis, social behavior, agonistic behavior in male mice, and maternal behavior. Ethology is a relatively new science and students might profit greatly in carrying out some behavioral studies. These studies would help train students to record their observations in a way that is amenable to analysis.

Other topics that could be studied are those of grooming and nesting behavior. Questions regarding grooming might include the time spent in grooming, incidence of social grooming, relationship of grooming to anxiety, feeding and sexual behavior. Nesting behavior could be investigated in terms of types and locations of nest, nesting materials preferred, and sex differences in nest building activities.

Reproduction and Growth

In the opinion of the writer, reproduction and growth studies were favorite topics of her junior high school students. This interest, inherent perhaps, in small mammal babies can be used to effect learning of many concepts through a wide variety of investigations.

Since conditions required for successfully breeding the red-backed vole and deermouse are not yet clear, students could attempt to determine these by varying parameters of the animals' environment.

One of these parameters is light. For example, they might see if increasing the photoperiod effects breeding in these animals as it does in *P. m. gracilis* (Price, 1966). The effect of different colors of light might also be investigated.

Temperature might be an important factor in initiating reproduction. *Microtus agrestis*, the field mouse, breeds less under low temperature conditions (5° C) with a summer diet than at summer temperatures (Baker, 1933).

Fecundity might be also affected by diet, although *Microtus agrestis* was found to be just as reproductively capable with a winter diet as with a summer one (Baker, 1933).

Another factor which might influence breeding behavior is that of the number and sex ratio of these

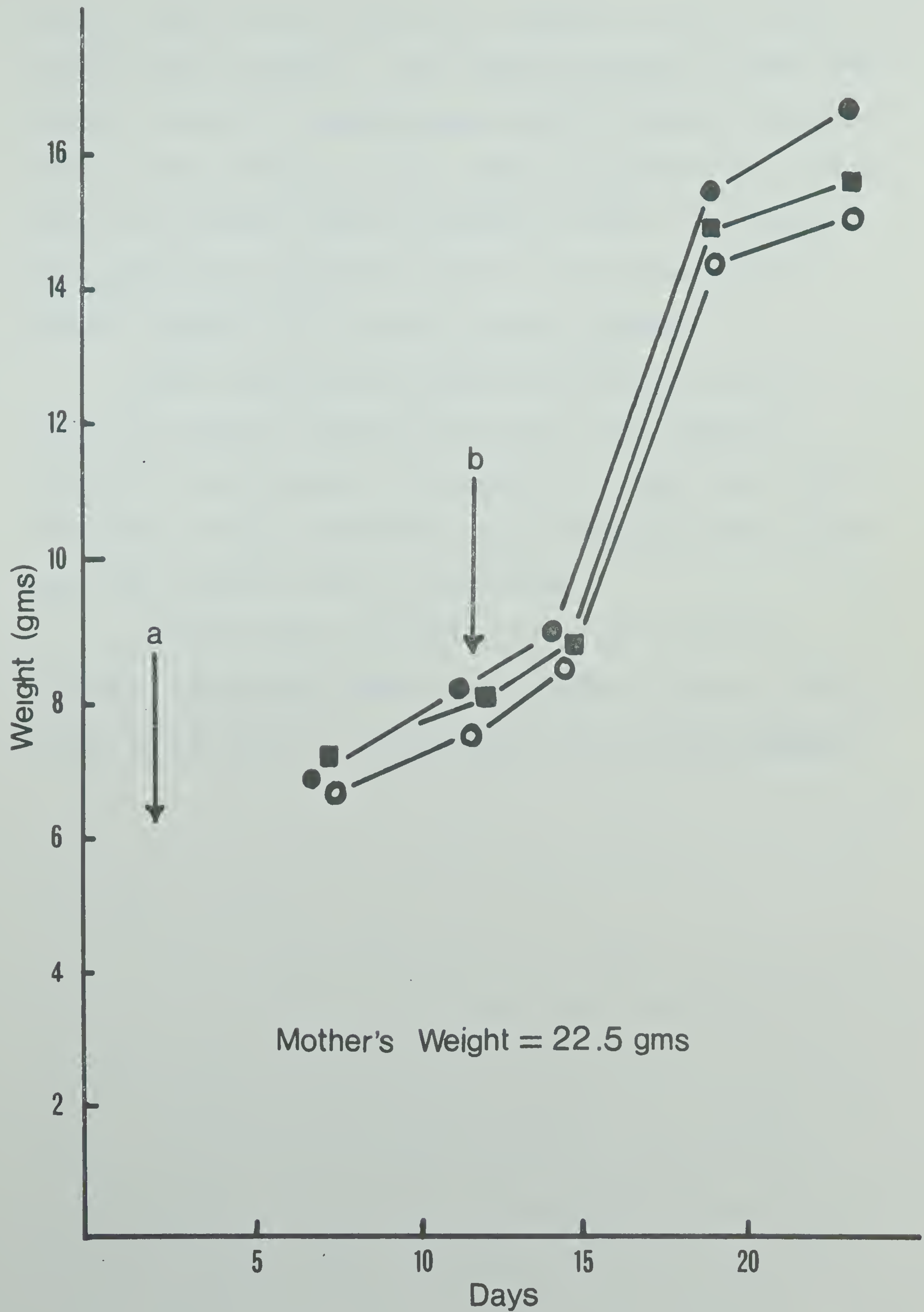
animals housed together in one cage.

Gestation period in the red-backed vole and deer-mouse is approximately 21 days (Fuller, 1969). During this time, weight gain, amount of food and water consumed, and behavior patterns in the pregnant female could be studied and compared with those of males and non-breeding females. For example, Lindborg (1950) found that *P. m. bairdii* females drank increasing amounts of water during pregnancy. One day before parturition 36 percent more water was consumed by breeding mice than non-breeding mice. Fourteen days after parturition, mothers drank 3.04 c.c. or 111 percent more than the controls, and after 22 days, 158 percent more. This has ecological significance in that since the breeding period is coincident with ideal moisture conditions, the latter might be a critical factor.

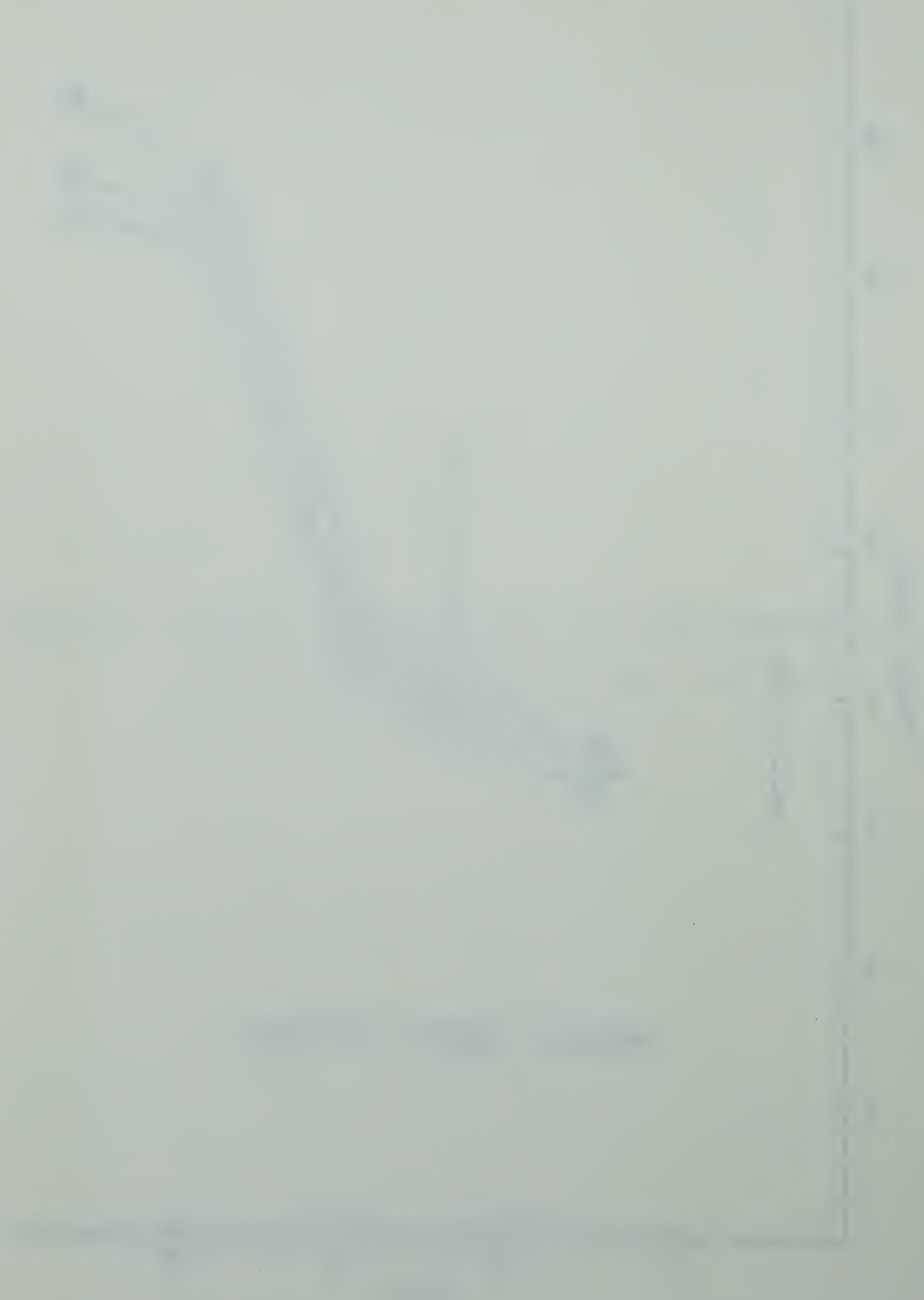
Once the young are born, many other investigations can be performed by students. The young should be marked as early as possible, in the manner described in Chapter IV.

Weight, tail, foot and ear length, and vibrissae development can be used to discover the typical sigmoid growth curve of animals (Hafez and Dyer, 1969; Brody, 1945). Figure 13 shows the growth pattern of a litter of *P. maniculatus* raised in the writer's classroom. Students might also determine the percentage of weight

Figure 13. Growth Pattern of a Litter of Three Deermice. a, fur appearing; b, eyes open, fur long, animals are active.



Weight (gms)
16
14
12
10
8
6
4
2
a
b
Mother's Weight = 22.5 gms
5
10
15
20
Days



gained daily by the young, and compare it with daily weight gain in adults. The growth pattern of males and females could be compared since males generally become heavier than females at the onset of puberty due to hormonal differences (Hafez and Dyer, 1969). The above data should be collected carefully and analyzed for means, ranges, etc. and the results graphed.

Other observations might include the age at which the pinnae become fully erect, the external auditory meatus opens, the eruption of upper and lower incisors, pelage appearance, the opening of eyes, weaning, moulting and onset of grooming.

Observations on maternal care and possible paternal assistance might also be made. Horner (1947) found some evidence of paternal care in *P. m. bairdii*.

CHAPTER VIII

SUMMARY AND CONCLUSIONS

Summary of Findings

During the period from September 1 to December 31 of 1968, few Edmonton grade eight science teachers used live mammals in their teaching, and even fewer used wild species. Those teachers with three years, or less, experience with the course, and who had taken several biology courses at a university used live mammals significantly more than their other colleagues. The data supports the work of Jacknicke (1968) which would indicate that native live organisms are not extensively utilized by classroom teachers in Alberta. This generalization requires more supportive data before it can be broadly accepted.

All teachers that use live mammal teaching agreed that the benefits to the student far outweighed any disadvantages of having the animals in the classroom.

Teachers interviewed expressed the opinion that use of feral mammal species required extra teacher involvement and facilities which were lacking in the schools. They suggested loosely defined categories of feral mammals that might be used in the classroom. The

lack of specificity may well indicate a lack of familiarity with feral species. A limited variety of suggestions was given by the interviewed teachers for the possible uses of feral mammals in the classroom. These stressed content, followed by the possibility that they might create student interest and be used as a vehicle for teaching pet care.

From September 1965 until August of 1969, trapping was carried out in various natural vegetative zones, in addition to habitats disturbed by man's activities. The deermouse was found to be available in all the areas sampled, though they were most prolific in areas surrounding man's farming activities. Red-backed voles were found to be restricted to wooded areas, preferably coniferous. The white spruce-poplar habitat was found to provide both species in fairly respectable numbers.

Commercial snap- and live-traps were generally used in the study and recommendations for easily constructed live-traps were made.

Maintenance of the animals was found to be fairly simple with a minimum of expense. Student assistance in care was found to be readily available on a volunteer basis. Breeding programs were largely unsuccessful, except where pregnant females were captured, in which cases, the young were successfully reared.

Several simple studies involving the red-backed vole and deermouse were carried out in the laboratory (May, 1966 to July, 1969) and in the classroom during the school terms of 1967-68 and 1968-69, involving a total of approximately 180 grade VII and VIII students. In addition, the writer reviewed the literature for ideas relating to projects that students could possibly carry out in the classroom. No evaluation of the usefulness of any of the projects on learning was made. However, it is the opinion of many educators that use of living organisms to illustrate biological concepts is a desired practice.

Recommendations for Further Study

This study was not sufficiently comprehensive to determine validly the extent of use of living mammals, particularly feral, in the classroom. We need to know a great deal more about the development of scientific attitudes through participation in such studies as well as the development of some appreciation for the processes of scientific inquiry, but there seems little doubt that their use in most Edmonton classrooms tends to be minimal. Successful breeding techniques for the red-backed vole and deermouse have yet to be discovered. Finally, methods of utilization of feral mammals in the classroom, and their effect on learning require much further investigation.

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APPENDICES

Appendix I

INTERVIEW FORMAT

INTERVIEW FORMAT

No. ___

Date______________________. Sex__________________.
Number of grade VIII science classes taught______________
Number of students in each class ______________
Number of years course has been taught ______________
Name of text or program presently used ______________

List of courses taken in biological science methods:

____
____

List of courses taken in biology and related fields at the university level:

____
____
____
____

Would you like to receive a copy of the results of this interview?_______________.

1. What live mammals did you use with your science classes from September 1 to December 31, 1968?

   Name of Species   No. of Individuals

   ____
   ____
   ____
   ____

2. Where and how did you obtain these animals?

   ____
   ____
   ____
   ____

3. How did you house these animals? (i.e. What types of cages did you keep these animals in?)

   ____
   ____
   ____
   ____

4. What did you feed these animals?

____
____
____
____

5. Were you able to breed any of these animals successfully? ____ If so, on how many occasions? __________

6. Did you find that having these animals posed any difficult problems? _______. If so, what was the nature of these problems?

   a. ____
   b. ____
   c. ____
   d. ____

7. Did you find that there are advantages to having these animals in your classroom? _____. What advantages?

   a. ____
   b. ____
   c. ____
   d. ____

8. For what specific purposes did you use these animals?

   a. ____
   b. ____
   c. ____
   d. ____

9. How long (weeks) did you maintain these mammals in your classroom?

   a. ____
   b. ____
   c. ____
   d. ____

10. For what reasons do you think teachers may not be making more extensive use of small wild mammals in their classrooms?

a. ________________
b. ________________
c. ________________
d. ________________

11. What small wild mammals found in the Edmonton region are readily obtainable for use in Junior High School science classes?

a. ________________
b. ________________
c. ________________
d. ________________

12. For what purposes might these wild animals be used in the science classroom?

a. ________________
b. ________________
c. ________________
d. ________________

Appendix II

LETTER OF INTENT TO TEACHERS SELECTED FOR PILOT STUDY

Parkallen Junior High School
6703 - 112 St.
Edmonton, Alberta

Dear

You have been selected to participate in a pilot study being carried out to determine the use of live mammals in the present Grade VIII science course.

Your contribution, if you decide to participate, will be the evaluation of the interview format which will be used in the actual study.

The information gathered from the project will be used by the author in a thesis for a Master's degree in Education.

It would be appreciated if you would be willing to spend approximately fifteen minutes after school with the author in the evaluation of the interviewing schedule. I will be calling you in the near future to determine if, and when, this interview will be convenient for you. Thank you in advance for your cooperation.

Yours truly,

(Mrs.) Jane Dyke

APPENDIX III

LETTER OF INTENT TO TEACHERS OF SAMPLE

Parkallen Junior High School
6703 - 112 Street
Edmonton 62, Alberta

Dear

You have been selected to participate in a study to determine the use of live mammals in the present Grade VIII Science course. If you decide to participate, your contribution will involve approximately fifteen minutes after school or at noon in consultation with me.

The results of this study will be used in a thesis for a Master's degree in Education under the advisorship of Professor C. G. Hampson. Your cooperation would be much appreciated, as it is hoped that this study will be of practical value to Science teachers in the province.

I will be calling you in the near future to determine if, and when, this interview will be convenient for you.

Thank you in advance for your cooperation.

Yours truly,

(Mrs.) Jane Dyke

APPENDIX IV

DESCRIPTION OF CAGES USED BY INTERVIEWED TEACHERS

DESCRIPTION OF CAGES USED BY INTERVIEWED TEACHERS

Species	Cage Description
1. White mice	Steel animal cages
2. Tame rabbits	Home-made wooden cages with wire mesh front
3. Bats	Wire-covered terrarium, rodent cage
4. Field mice	Wire-covered aquarium, home-made wire mesh cage
5. Hamsters	Wire bird cage
6. Guinea pigs	Home-made wooden cage
7. Gerbils	Home-made wooden cage

APPENDIX V

DESCRIPTION OF DIETS ON WHICH ANIMALS WERE MAINTAINED BY INTERVIEWED TEACHERS

DESCRIPTION OF DIETS ON WHICH ANIMALS WERE MAINTAINED BY TEACHERS INTERVIEWED

Species		Description of Diet
1.	White mice	Hamster food, greens*, grains, carrots, bread, cookies
2.	Tame rabbits	Alfalfa, farina, greens
3.	Bat	Raw hamburger
4.	Field mice	Lab chow, grains, carrots, cookies
5.	Hamsters	Hamster food
6.	Guinea pigs	Alfalfa
7.	Gerbils	Lab chow, greens

* In many cases, the greens were obtained from grocery stores where these were being discarded.

APPENDIX VI

EXPLANATION OF CATEGORIES OF REASONS GIVEN BY INTERVIEWED TEACHERS FOR NOT USING LIVE FERAL MAMMALS IN THE CLASSROOM

EXPLANATION OF CATEGORIES OF REASONS GIVEN BY INTERVIEWED TEACHERS FOR NOT USING LIVE FERAL MAMMALS IN THE CLASSROOM

1. Extra teacher involvement required- too much trouble, care during holidays, hard to handle, time for preparation of activities, difficult to obtain.
2. Lack of facilities- both for collecting and maintaining.
3. Lack of teacher knowledge- where to obtain, what activities to set up, how to care for them.
4. General inconvenience- smell, sickness of animals.
5. Legal and humane aspects- against law to keep wild animals in captivity, detrimental to animals, parents will complain about cruelty of dissection.
6. Study of mammals too advanced or inappropriate at this level- too much material in the present course to allow detailed study of animals, mammal study too advanced, such study does not fit into the present course.
7. Other methods superior- such as pictures, field trips to their natural environment.

APPENDIX VII

EXPLANATION OF CATEGORIES OF REASONS GIVEN BY INTERVIEWED TEACHERS FOR USING LIVE FERAL MAMMALS IN THE CLASSROOM

EXPLANATION OF CATEGORIES OF REASONS GIVEN BY INTERVIEWED TEACHERS FOR USING LIVE FERAL MAMMALS IN THE CLASSROOM

1. <u>To study structure</u>- general and comparative anatomy, external features in relation to classification.
2. <u>To study ecology</u>- natural diet, adaptations to environment, seasonal changes in fur.
3. <u>To study reproduction</u>- parental care, sexuality, growth and development, variability and heredity.
4. <u>To study behavior</u>- conditioning experiments, feeding behavior, grooming, social order, communication.
5. <u>To create student interest</u>
6. <u>To learn care of pets</u>
7. <u>To study metabolism-</u> oxygen consumption, effect of drugs on metabolism.
8. <u>To recognize local fauna</u>

APPENDIX VIII

PEROMYSCUS DIET

The following is an improvised ration for Peromyscus as developed by Dice (1934). The ingredients are combined in proportion by weight.

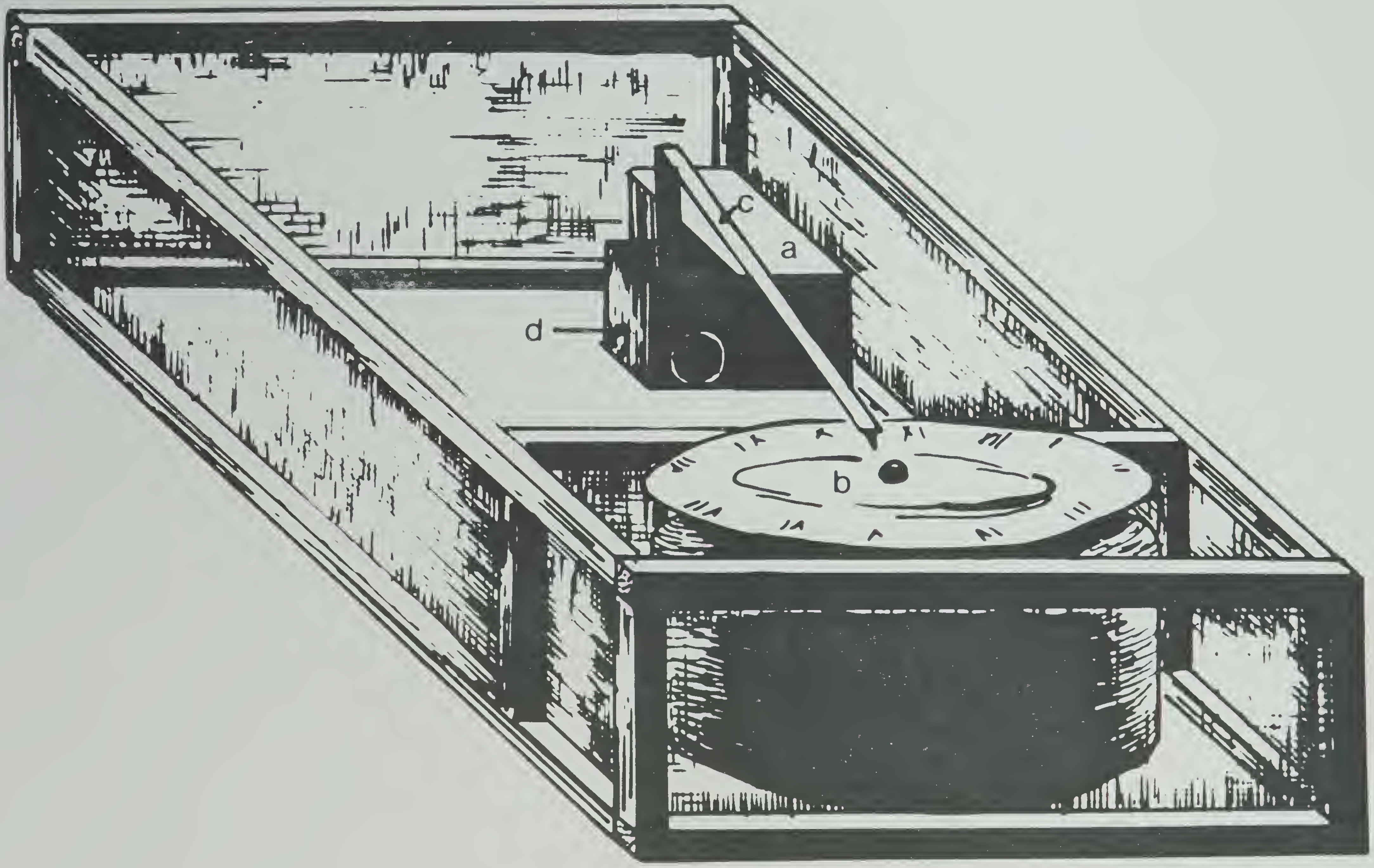
Rolled oats	53	Sunflower seed	1.5
Dry meat scraps	20	Hemp seed	1
Dry skim milk	10	Canary seed	1
Whole wheat	5	Millet seed	1
Wheat germ	5	Iodine sale	0.5
Cod liver oil	2		
			100.0

In addition, lettuce trimmings should be fed twice weekly. He found that this diet was successful for breeding purposes.

APPENDIX IX

ACTIVITY RECORDER

Appendix IX. Activity Recorder With Cover Removed. The animal leaves its nest box through a swinging door to enter the feeding chamber. The motion of the swinging door is recorded on the smoked paper attached to the electric clock motor. a, nest box; b, clock recorder (smoked paper attached to an electric clock); c, recording arm; d, housing containing swinging door, attached to recording arm. Modified after Triner (1965).


c
a
d
b